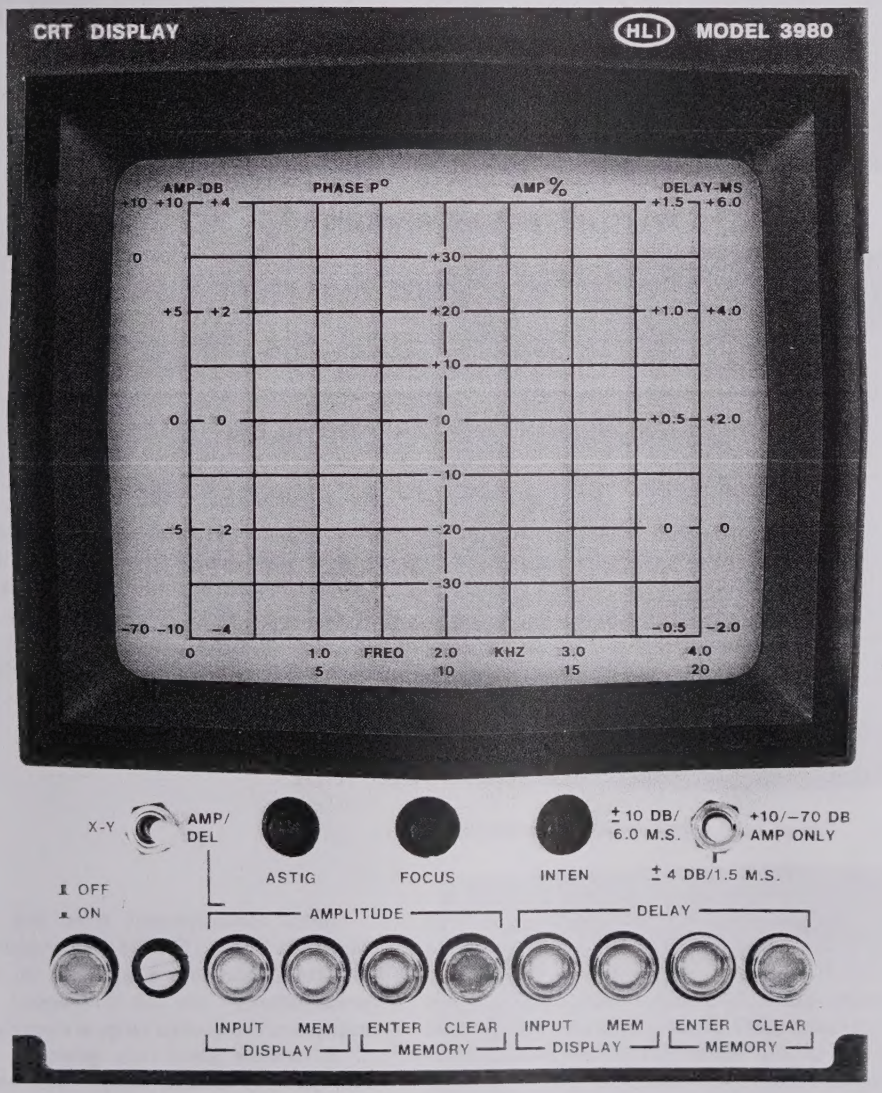
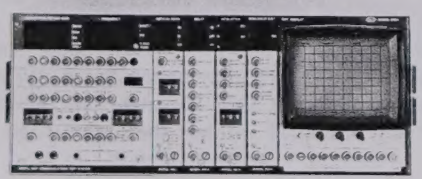
HEKIMIAN LABORATORIES INC.

CRT DISPLAY

MODEL 3980





THE MODEL 3900 COMMUNICATIONS TEST SYSTEM

The modular communications test system you can never outgrow! The noise, level, frequency and return loss measurement capabilities of the Basic Unit can be expanded with a large family of plug-in modules to meet your present and future needs.

CRT DISPLAY — MODEL 3980

- DISPLAYS
  - AMPLITUDE – REAL TIME
  - AMPLITUDE – MEMORY
  - DELAY*– REAL TIME
  - DELAY*– MEMORY
  - AMPLITUDE AND DELAY*– ANY COMBINATION OF ABOVE
  - WIDE-RANGE AMPLITUDE – REAL TIME
  - WIDE-RANGE AMPLITUDE – MEMORY
  - WIDE-RANGE AMPLITUDE – REAL TIME/MEMORY
  - X-Y* IMPAIRMENT (PHASE/AMPLITUDE)
- DUAL AMPLITUDE/DELAY RANGES
- +10 TO –70 DBM WIDE-RANGE AMPLITUDE DISPLAY
- 4 KHZ AND 20 KHZ FREQUENCY SCALES
- INDIVIDUAL MEMORY ENTER AND CLEAR BUTTONS
- COMPLETELY FILLS MEMORY IN A SINGLE SWEEP
- INSTANT AND COMPLETE ERASURE OF MEMORY
- 256 BIT MEMORY RESOLUTION
- BAR GRAPH X-Y IMPAIRMENT DISPLAY
- FOUR SINGLE-WIDTH MODULES WIDE

*When used with appropriate modules.

The Model 3980 CRT DISPLAY presents amplitude, delay and dynamic phase and amplitude jitter impairment displays in a four-unit wide module that plugs into the Model 3900 COMMUNICATIONS TEST SYSTEM. These real time and memory (digitally stored) CRT displays augment the standard X-Y plotter outputs of the Model 3900 Basic Unit to provide true flexibility in measurement presentation. All real time measurements displayed on the CRT screen are simultaneously displayed to full measurement accuracy by the digital readouts of the basic unit and other plug-in modules.

Normal, expanded and wide-range amplitude displays may be made directly using the Model 3980 CRT DISPLAY. The ±10 dB normal range and the ±4 dB expanded range allow excellent resolution during line conditioning and detailed channel response measurements. The 80 dB wide-range amplitude display provides a level versus frequency presentation when a wide dynamic range display is desired.

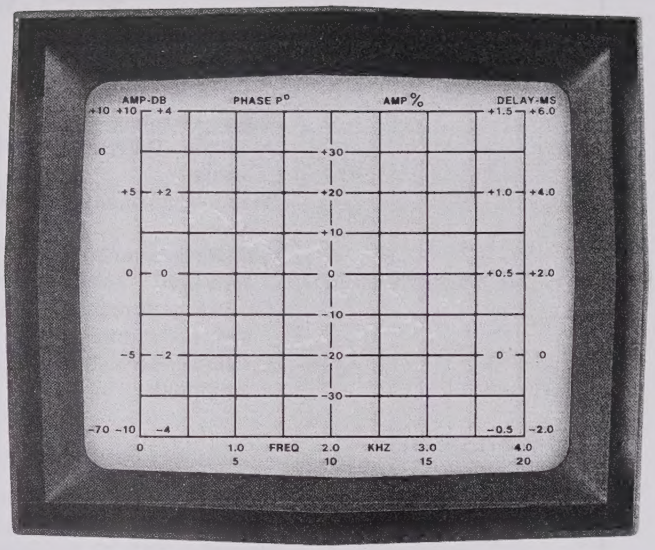
Delay measurements from the Model 3912 (USA) or Model 3917 (CCITT) DELAY modules may be displayed with or without the amplitude traces for detailed channel response presentations. An 8.0 millisecond normal range and a 2.0 millisecond expanded range are provided.

A flexible Basic Unit generator with single and continuous sweeps, variable sweep rates and front panel adjustable sweep limits increases the usefulness and convenience of the CRT presentation.

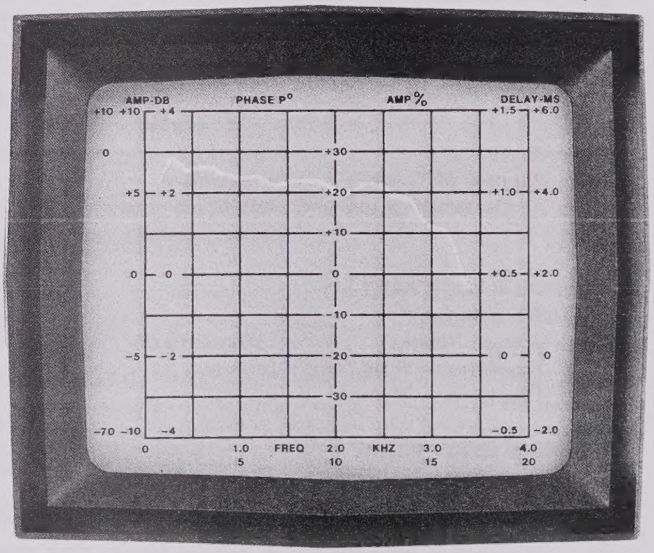
The X-Y impairment display accepts the phase and amplitude jitter signals from the Model 3913 HITS/JITTER module and provides a real time visual display for evaluating a facility's short term and transient behavior.

The Model 3980 is a four-unit wide module weighing approximately 6½ pounds. It may be located in any plug-in location including the Model 3910 Expander Unit, and can be easily inserted and extracted without the use of hand tools.

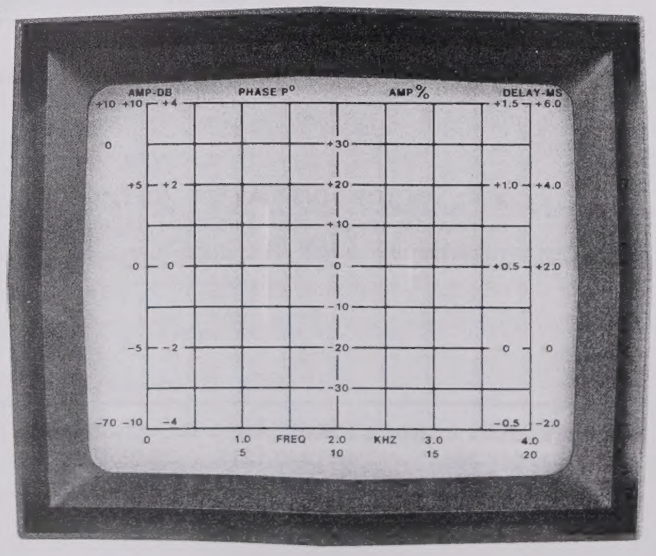
AMPLITUDE/DELAY – Any combination of amplitude and delay, real time and memory traces may be displayed. Normal and Expanded ranges, dashed delay trace identification and 4 kHz and 20 kHz frequency scales are some of the features that make this display unique.



WIDE-RANGE AMPLITUDE – An 80 dB dynamic range provides a level tracer type display with both real time and memory traces. Single-sweep memory storage and instantaneous clear combine with the variable sweep rate and adjustable sweep limits of the basic unit for flexible display.



X-Y IMPAIRMENT DISPLAY – Phase jitter and amplitude jitter are presented in a dual bar graph display that allows real time visual evaluation of short term and transient line problems.



SPECIFICATIONS*

DISPLAY MODES
- Amplitude – real time
- Amplitude – memory
- Delay – real time
- Delay – memory
- Amplitude/Delay – any of above
- Wide-Range Amplitude – real time
- Wide-Range Amplitude – memory
- Wide-Range Amplitude – real time and memory
- X-Y Impairment (Phase/Amplitude)

AMPLITUDE/DELAY DISPLAY

Display Range	Expanded – ±4 dB amplitude +1.5 to –0.5 ms delay Normal – ±10 dB amplitude +6.0 to –2.0 ms delay
Accuracy	±5% of F.S.
Resolution – Real Time	Infinite
Resolution – Memory	Expanded – 0.03 dB amplitude; 8 μs delay Normal – 0.08 dB amplitude 31 μs delay
Accuracy	±5% of F.S.
Number of Traces	4 maximum
Trace Identification	Amplitude – continuous Delay – dashed

WIDE-RANGE AMPLITUDE DISPLAY

Display Range	+10 to –70 dB
Resolution – Real Time	Infinite
Resolution – Memory	0.31 dB

FREQUENCY SCALE

Scale Range**	40 Hz to 4 kHz 40 Hz to 20 kHz
Resolution – Real Time	Infinite
Resolution – Memory	Amplitude/delay – 32 Hz (4 kHz range); 155 Hz (20 kHz range)
	Wide-Range Amplitude – 16 Hz (4 kHz range) 77 Hz (20 kHz range)
Sweep Rate**	8 Hz per second to 1 kHz per second

MEMORY ENTER TIME Complete trace storage in a single sweep

MEMORY CLEAR TIME Instantaneous

X-Y IMPAIRMENT DISPLAY

Phase	Range – 0^{o} to $\pm 30^{o}$
Amplitude	Range – 0% to ±30% amplitude modulation

GRATICULE SIZE 80 mm (X axis) x 70 mm (Y axis)

MODULE SIZE 4 single-width module spaces 5.4 in. (13.7 cm) W x 6.75 in. (17.2 cm) H x 13.88 in. (35.3 cm) D

MODULE WEIGHT 6 lbs. 8 oz.

OPTIONS
- .01 – X-Y Vector Display***
- .02 – Deletes dashed delay trace identification

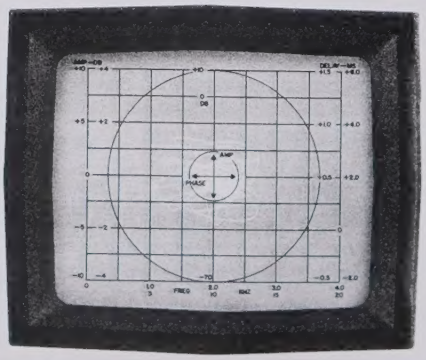
*All stated and unstated specifications are intended to comply with Bell System standards as contained in Bell System Technical Reference PUB 41009 dated May 1975

**Specification dependent on basic unit

***Licensed from Bradley Telcom, U.S. Patent No. 3,906,173

HLI reserves the right to make changes in specifications at any time without notice.

X-Y VECTOR DISPLAY* (OPTION .01)** – Provides phase and amplitude jitter display in real time.



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PERFORMANCE CHECKS

CRT MODEL 3980

3.01 This section contains the procedure for testing the performance of the Model 3980.

A. Set up the basic unit as follows:

1) Set ABS/REL switch to ABS.
2) Set REC-LEVEL switch to in position.
3) Set 60 HZ switch to out position.
4) Set DAMP switch to out position.
5) Set REC FREQ switch to in position.
6) Set 20 KHZ/4 KHZ switch to 4 KHZ
7) Set CONT/STEP switch to CONT.
8) Set SF SKIP switch to out position.
9) Set AUTO switch to in position.
10) Adjust DOWN LIMIT control fully counter-clockwise.
11) Adjust UP LIMIT control fully clockwise.
12) Set HZ/SEC control to 100.
13) Set QUIET TERM switch to out position.
14) Set DIAL/TK switch to out position.
15) Set BRIDGE/TERM switch to TERM.
16) Set NORM/RETURN LOSS switch to NORM.
17) Set SEND LEVEL (DBM) thumbwheel switches to -00.0.
18) Loop NORM-SEND jack to NORM-REC jack.
19) Set POWER switch to in position.

B. Set up the Model 3980 as follows:

1) Set ON/OFF switch to ON.
2) Set toggle switch on the left to X-Y.
3) Adjust INTEN, FOCUS and ASTIG controls for a well-defined trace.
4) Note that the CRT trace appears as a pair of dots in the center of the graticule.
5) Set toggle switch on the left to AMP/DEL.
6) Set AMPLITUDE DISPLAY INPUT switch to in position.
7) Set AMPLITUDE DISPLAY MEM switch to in position.

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8) Set AMPLITUDE MEMORY ENTER switch to in position.

C. Perform Self-test procedure as follows:

1) Set toggle switch on the right to ±10 DB.
2) Observe that the trace is within ±1 dB of the corresponding 0 DB reference line.
3) Set toggle switch on the right to ±4 DB.
4) Observe that the trace is within ±0.4 dB of the corresponding 0 dB reference line.
5) Set toggle switch on the right to +10/-70 DB.
6) Observe that the trace is within ±4 dB of the corresponding 0 dB reference line.
7) Set AMPLITUDE DISPLAY INPUT switch to out position.
8) Set AMPLITUDE DISPLAY MEM switch to out position.
9) Set AMPLITUDE MEMORY ENTER switch to out position.
10) Set DELAY DISPLAY INPUT switch to in position.
11) Set DELAY DISPLAY MEM switch to in position.
12) Set DELAY MEMORY ENTER switch to in position.
13) Momentarily press ON/OFF switch on an installed delay module and observe that the ON/OFF LED is on.
14) Set toggle switch on the right to 6.0 MS.
15) Momentarily press the ZERO REF switch on the installed delay module and observe that the trace is located on the 0 MS reference line.
16) Set toggle switch on the right to 1.5 MS.
17) Observe that the trace is located on the 0 MS reference line.
18) On the Model 3980 set X-Y/DEL switch to X-Y.
19) On the Model 3913 Hits/Jitter module, set HITS/JITTER switch to JITTER and POWER ON. Ensure that all other pushbutton switches are in the out position.
20) Set the phase hit thresholds to 50^{o} and gain set threshold to ±10 dB.
21) Press TEST on Model 3913 and observe on Model 3913 displays:

16.9^{o} $\pm 0.5^{o}$ phase jitter

14.6% ±0.5% amplitude jitter

22) On Model 3980 CRT Display, observe vertical lines of 17^{o} phase jitter below PHASE P^{o} on graticule and ±15% amplitude jitter below AMP%.

NOTE

Read all of line

Read only half of line.

DIAGNOSTICS
MODEL 3980
CRT DISPLAY

A. GENERAL - This section provides an orderly procedure for isolating a malfunction in the M3980.

DANGER: DANGEROUSLY HIGH VOLTAGE

The M3980 utilizes voltage potentials in excess of 2.0 kV. Operation of the module on an extender card or removal of the sheet metal enclosure exposes the technician to these dangerously high voltages. Extra care and thought are essential when troubleshooting or aligning this module.

B. Diagnostic Chart

1. The M3980 Display is dark in X-Y and instensity control is fully clockwise.

TEST	ACTION	
1.01 Is the basic unit operating properly (displays lit and correct readings)?	NO:	Repair basic unit.
	YES:	Go to 1.02.
1.02 Is the M3980 properly installed?	NO:	Install module correctly.
	YES:	Go to 1.03.
1.03 Check voltages on vertical edge connector (use extender card for convenience).	NO:	Go to 1.04.
	YES:	Go to 1.05.

Voltage with Respect to Pin A

B +15 ±1 V dc

C +6.00 ±0.02 V dc

E -15 ±1 V dc

$\overline{K}$ Display +5 ±0.5 V dc

1.04 Remove M3980 and other modules one at a time, repeating the measurements in 1.03. Does removal of any module return the voltages to normal?	NO: Repair basic unit. YES: Repair offending module. (If M3980, go to 1.05)
1.05 Identify the voltage which is out of range with the M3980 installed.	
+15 V (Pin B) low?	Go to 1.06.
-15 V (Pin E) low?	Go to 1.07.
+6.00 V (Pin C) out of tolerance?	Locate the shorting path from Pin C to ground.
Display +5 V (Pin $\overline{K}$) low?	Locate the fault in the 400 board switching supply. All ok, go to 1.08.
1.06 Place the M3980 on an extender card and test for the following voltages:	
J2-3 +5 ±0.2 V dc low?	YES: Locate excessive load on +5 V supply. NO: Continue.
J2-6 +10 ±0.2 V dc low, J2-3 is ok	YES: Locate excessive load on +10 V supply. NO: Continue.
J2-7 +6.00 ±0.02 V dc low? J2-8 -6.00 ±0.02 V dc low?	YES: Locate fault in ±6 V reference supply. NO: Go to 1.07.
1.07 Place the M3980 on an extender card and test for the following voltage:	
J2-4 -10 ±0.2 V dc low?	YES: Locate excessive load on -10 V supply. NO: Go to 1.08.

1.08 Verify the voltages of the 400 board switching supply. Is your voltmeter capable of handling 2.0 kV? See Paragraph A concerning high voltage.

J7-5 +190 ±10 V dc

J7-2 -2.0 ±0.1 kV dc

Are the voltages ok?

YES: Repair fault in 300 board or replace CRT.

NO: Repair fault in 400 board switching supply.

2. Display on CRT "blooms" (X-Y or AMP/DEL)

TEST	ACTION	
2.01 Are the intensity, astigmatism, and focus controls adjusted?	YES:	Go to 2.02.
	NO:	Adjust front panel controls.
2.02 Is the DISPLAY +5 V supply on vertical edge connector +5 V dc ±0.5 V dc?	YES:	Go to 1.08.
	NO:	Locate fault in the 400 board switching supply.

3. X-Y display is malfunctioning, AMP/DEL functions are proper.

TEST	ACTION	
3.01 Are the M3913 analog outputs correct? Use a voltmeter on the basic unit rear panel to check.	YES:	Repair fault on 500 board.
	NO:	Repair M3913.

4. Display faults in AMP/DEL mode.

TEST	ACTION	
4.01 In the AMP/DEL mode, does the INPUT signal dot line up with the stored trace as it is entered into the memory?	NO:	Realign and repair, if necessary, the A/D converter, the horizontal and vertical D/A converters.
	YES:	Go to 4.02.

4.02 Do the zero traces (such as 0 dB, 0 ms) align with the graticule zero lines?	NO:	Check the basic unit, M3912, M3917 analog signals on the basic unit rear panel.
	YES:	Go to 4.03.
4.03 Does the frequency shown on the display agree with that displayed on the basic unit frequency counter?	NO:	Check the basic unit FREQ ANLG signal on he rear panel at 1000 Hz and 4000 Hz.
	YES:	Go to 4.04.
4.04 Did any of the above checks reveal the problem?	NO:	Perform the alignment procedure and if necessary repair the M3980 300 board.
	YES:	Go to 4.05.
4.05 Are the display traces tilted with respect to the horizontal graticule lines?	YES:	Adjust the twist coil driver on the M3980 300 board.
	NO:	Go to 5.01.

5. Digital storage trace troubles.

TEST	ACTION	
5.01 Are the clock generator outputs correct?	NO:	Repair clock generator circuitry.
	YES:	Go to 5.02.

IC Pin #	Positive Pulse Duration	Period
IC19-1	1 µsec	2 µsec
IC36-7	4 µsec	8 µsec
IC36-9	72 µsec	128 µsec
IC7-6	7 µsec	1 µsec
IC6-3	252 µsec	4 µsec
IC44-15	16 µsec	32 µsec
IC38-12	8.2 msec	16.4 msec

5.02 Is the sweep generator functioning?

IC Pin #	Squarewave Period
IC34-6	64 µsec
IC34-11	128 µsec
IC34-14	256 µsec
IC34-2	512 µsec
IC44-6	1024 µsec
IC44-11	2.04 msec
IC44-14	4.10 msec
IC44-2	8.20 msec

NO: Repair sweep generator.

YES: Go to 5.03.

5.03 Is the frequency latch functioning? Set the basic unit to AUTO sweep from 100 Hz to 4 kHz. Using an oscilloscope count the approximate number of level changes during a single frequency sweep (up or down) on the IC pins listed below:

IC Pin #	Number of Level Changes
IC40-1	1
IC40-11	2
IC40-10	4
IC40-2	8
IC37-1	16
IC37-11	32
IC37-10	64
IC37-2	128

NO: Repair frequency latch on D/A converter.

YES: Troubleshoot front panel switch control logic.

MODEL 3980 100-200 BOARD TEST PROCEDURE

I. TEST SET-UP

A. Equipment Required

1. Digital Multimeter 0.1% DC accuracy
2. Oscilloscope
3. Model 39[illegible] test bed unit
4. Model 3980 Test Box

B. Equipment Hook-Up

1. Remove the top from the Model 3900 Mainframe.
2. Plug in the 200 board, which is attached by two flat cables to the 100 board, in a slot on the left side of the Model 3900. DO NOT USE AN EXTENDER CARD!
3. Place an insulator (cardboard) beneath the 100 board and check to see that it is not shorted to anything.
4. Connect the digital multimeter in the volts scale between the terminal marked +5 on the 200 board and the terminal marked GND.
5. Plug in the Model 3980 Test Box.

Visual and/or Mechanical Checks

Set pot R17 to mid scale.

[illegible] the power switch (left most switch) in the out (OFF) position.

Set S11 in the AMP/DEL position. Toggle away from keyway.

4. Visually inspect the board for missing or improperly installed components, jumpers, and solder bridges.

II. POWER-UP AND POWER SUPPLY TEST

A. Power-Up

1. Turn on the Model 3900 Mainframe.
2. Check the DC voltage in all supply voltage test points on the 200 board. It must be 0.0 ±0.5 V dc.
3. Turn on the Model 3980 100-200 board combination by actuating S1.
4. Connect the DC voltmeter to the supply test points on the 200 board and verify that they meet the following tolerances:

TEST POINT	VOLTAGE
+15	+15 ±1 V dc
-15	-15 ±1 V dc
+10	+10 ±0.4 V dc
-10	-10 ±0.4 V dc
+6	+6.00 ±0.02 V dc
-6	-6.00 ±0.02 V dc

B. D/A Reference Supply Adjustment

1. Connect the DC voltmeter to the 2.56 V test terminal on the 200 board.
2. Trim R5 on the 200 board so that the voltage is 2.560 ±0.002 V dc.

C. Ripple Check

1. Connect the scope to each output voltage test terminal and observe the ripple voltage. It must be 20 millivolts peak-

to-peak or less on every supply.

2. Turn off the 100-200 board combination with S1.

III. A-D CONVERTER ALIGNMENT

A. Remove IC27, a 4066, and place in conductive foam.

B. Connect the oscilloscope:

1. 1 channel to IC36-12 (SAR LSB).

2. 2nd channel to TP4 (summing mode).

3. External trigger to IC36-11. (end of conversion positive edge).

C. Using a clip lead, tie TP1 to TP2.

D. Turn on power switch S1, and trim R19 such that the conversion just changes from 11111110 to 11111111. This may be observed by watching IC36-12, the LSB (BIT Ø) of the conversion. Verify that BITS 1, 2, and 3, IC36-13, 14, 15 are all high.

E. Remove the clip lead from TP2 and connect it to TP3.

F. Adjust R17 such that the conversion just changes from 00000001 to 00000000. This is done by observing IC36-12, the LSB (B Ø) of the conversion. Verify that BIT 1, 2, and 3 (IC36-13, 14, 15 are all low.

G. Repeat steps C and D.

H. Repeat steps E and F.

I. Repeat steps C and D.

J. Repeat steps E and F.

K. Turn off the power, S1. remove the clip lead from TP1, 2, 3. Reinsert IC27 a 4066 into its socket.

VERTICAL D-A ALIGNMENT

A. Tie TP5 to TP9 (+5 V) with a clip le

I. Connect digital voltmeter to TP6.

C. Turn on power, S1 and adjust R29 so that the voltage at TP6 is 2.560 ±0.001 V dc.

V. HORIZONTAL D-A ALIGNMENT

A. Tie TP7 to TP9 (+5 V) with a clip lead.

B. Connect the digital voltmeter to TP8.

C. Adjust R73 so that the voltage at TP8 is 2.560 ±0.001 V dc.

D. Turn off the power S1, and remove the clip lead from TP7, 9.

VI. HORIZONTAL CHANNEL CHECKOUT

A. Set up the basic unit. All buttons are out except:

1. Level (REC) - Row 1
2. REC FREQ - Row 2
3. TIMER DON'T CARE
4. 20 KHZ/4 KHZ - Row 3
5. MAN - Row 3
6. ALL THUMBWHEELS to ±00.0 - Row 4.
7. BRIDGE/TERM - Row 5.
8. Install looping cord in send and receive jacks.

B. Connect the scope to IC49-2.

C. Adjust the generator for 2000 ±5 Hz with the manual tune pot on the basic unit front panel. Turn S1 on.

D. The scope must show a triangular wave with a period of 16.4 ±0.5 msec and an amplitued of 2.56 ±0.1 V dc and a minimum voltage of 0.0 ±0.1 V ac.

E. The waveform must also show a horizontal line at 1.28 ±0.2 V dc.

F. Reduce the generator frequency to 1000 ±5 Hz with the manual tune control and the horizontal line must then be at 0.64 ±0.2 V dc.

G. 1. OPTION- Throw the X-Y AMP/DEL to X-Y, (towards keyway) and observe that the output is a steady level of 1.28 ±0.1 V dc. Throw the X-Y- AMP/DEL switch to AMP/DEL (away from keyway).

2. NO OPTION- Throw the X-Y AMP/DEL to X-Y, (towards keyway) and observe that the output is a 1 kHz square wave 1.0 ± 0.2 V peak-to-peak centered about 1.28 ±0.1 V dc.

VII. VERTICAL CHANNEL CHECKOUT

A. Connect the scope to IC20-2. Set 3980 test box to -2 ms.

B. Operate S5 and S9 to clear the memories. Also operate S4 and S8.

C. Observe the scope at a sweep rate of 2 ms/cm. You will see 3 lines. One at 1.28 ±0.2 V dc, one at 0.0 ±0.2 V dc and one at -0.35 ±0.2 V dc.

D. Throw S10 toggle to the amplitude only position (toggle away from keyway), press the AUTO button on row 3, set the sweep limits to max, and 200 Hz, and set HZ/SEC to maximum (> 100 HZ/SEC).

E. Observe a solid voltage of 2.3 ±0.2 V dc note, there is a small segment which is not written around <200 Hz.

F. Press both clear switches S5 and S9 and observe the traces being written from 0 V to 23 V.

G. Throw S10 to the opposite position (toggle toward keyway). Set 3980 test box to 1 ms.

H. Press the clear switches and observe the trace writes a line at 0.96 ±0.2 V dc.

I. Set box to -.5 ms.

J. Press the clear switches and observe the trace writes a line at 0.48 ±0.2 V dc. Set test box to Dot.

K. Throw the X-Y- AMP/DEL to X-Y, and observe that the output is a steady level of 1.29 ±0.1 V dc. Throw the X-Y- AMP/DEL switch to AMP/DEL (away from keyway).

VIII. BLANKING CHECKOUT

A. Throw S10 to center. Set test box to 0 ms and allow the memory to write.

B. Connect the scope to IC9-4 and observe the blanking waveform.

C. Release all display switches: S2, 3, 6, 7. The waveform on IC9-4 must be a steady 5V level.

D. Depress S3 and observe negative going pulses is now 8 ±1 μsec duration and a 64 ±2 μsec period.

E. Depress S7 and observe that the period of the pulses is now 32 ±2 μsec.

F. Now depress S2 and observe that the period is now 16 ±2 μsec.

G. Release S2 and depress S6 and observe that the period is again 16 ±2 μsec.

MODEL 3980 CRT DISPLAY MODULE

400 BOARD TEST PROCEDURE

9-20-77

I. Test Set Up

A. Equipment required

1. Model 3980 400 board test set.
2. Ammeter 0-5 Amperes
3. DC voltmeter 0 to 4 K V DC.
4. Digital Multimeter Data Precision 245 or equivalent
5. CRT oscilloscope

B. Equipment Hook Up

1. Connect the 0 to 5 A meter between the +5 V green terminals on the 400 board Test Set. The left terminal is (+).
2. Connect a jumper across the two green +12 V terminals on the Test Set.
3. Connect the Digital Multimeter in the DC volts position between the right +5 V green terminal and ground.
4. Connect the high voltage DC meter from J 7-3 to ground. The ground terminal is (+).
5. Connect the scope between one of the 2N6306 collectors and ground.
6. Plug in the 400 board under test with the component side forward.
7. Connect the +5 V connections J9, and the dummy load J7 with the connectors on the Test Set.

C. Mechanical Checks

1. Set Adjustment pot R22 to midscale.
2. Carefully check that the high voltage connections are not exposed or shorted to the operator or anything else!!

II. Power Up

Note: This PC board produces dangerously high voltages. Think before acting.

A. Initially set all Test Set switches to OFF.

B. Plug the Test Set into 115 V AC.

C. Turn on the AC power.

D. Turn on the +5 V switch (+12 V switch is off). Adjust the front panel pot for 5.5 ±0.1 V DC.

E. Observe the 5 V current, it must be < 1 ma. Return the ammeter to 5 A scale.

F. Connect the digital voltmeter on the 1000 V DC scale to the (+) side of C27.

G. Turn on the +12 V switch and observe the 5V current. It must be < 3.0 amperes. If not, turn off the test set immediately.

III. 190 V Adjustment

A. Trim pot R22 for a reading of 190±1 V DC on the digital voltmeter.

B. Turn off the 12 V switch. Remove the digital voltmeter from C27 and connect it to the right side green 5V terminal. Turn on the 12 V switch.

C. Adjust the front panel pot for 5.0 ±0.1 V DC if necessary.

D. Turn off the 12 V switch. Reconnect the digital voltmeter on the 1000 V scale to the (+) side of C27. Turn on the 12 V switch.

E. Trim R22 for 190 ±1 V DC again if required.

F. Observe the High Voltage meter, it must read 2.0 ±0.1 K V DC.

Observe the 5 V current, it must read 2.20 ±0.24 Amps DC.

Turn off the 12 V switch and connect the digital voltmeter to the right-side green 5 V terminal.

IV. Input Supply regulation range

A. With the front panel supply set to 5.0 ±0.1 V DC, observe the collector waveform on the scope. The positive and negative pulses will be of less than 50% duration (the regulator uses pulse width control to regulate the power into the transformer).

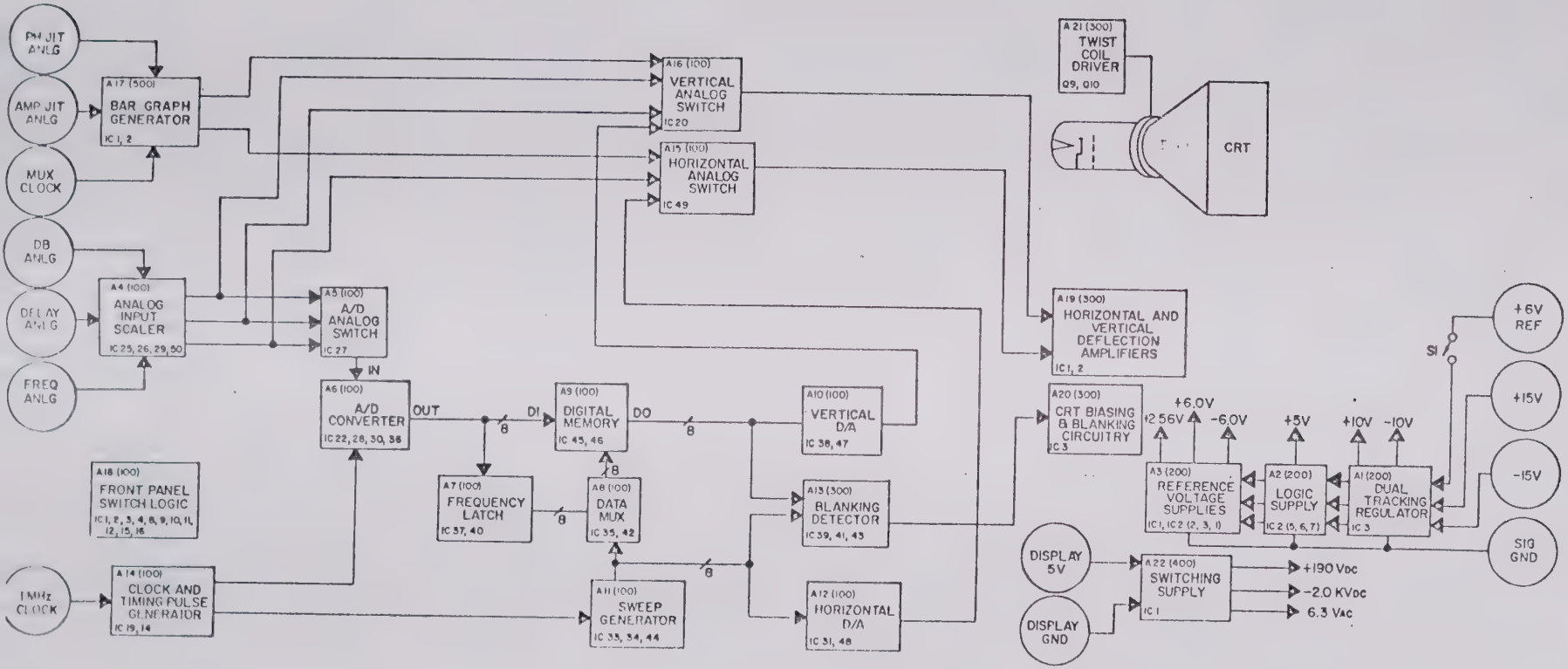
B. Slowly reduce the 5 V supply with the front panel pot until the regulator can no longer compensate, and the waveform is a full 50% duty cycle. Observe the supply voltage at this point, it must be 4.40 ±0.35 V DC.

C. Return the 5 V supply to 5.0 ±0.1 V DC. Turn off the -12 V switch.

V. Filament winding check

A. Connect the Digital Multimeter in the AC volt range to the filament dummy load.

B. Turn on the +10 V supply switch and record the filament voltage. It must be 5.5 ±0.5 V AC.


DM JIT ANLG
AMP JIT ANLG
MUX CLOCK
DB ANLG
DELAY ANLG
FREQ ANLG
1MHz CLOCK
A17 (500) BAR GRAPH GENERATOR IC 1, 2
A4 (100) ANALOG INPUT SCALER IC 25, 26, 29, 50
A3 (100) A/D ANALOG SWITCH IC 27
A6 (100) A/D CONVERTER IC 22, 28, 30, 36
A18 (100) FRONT PANEL SWITCH LOGIC IC 1, 2, 3, 4, 8, 9, 10, 11, 12, 15, 16
A14 (100) CLOCK AND TIMING PULSE GENERATOR IC 19, 14
A16 (100) VERTICAL ANALOG SWITCH IC 20
A15 (100) HORIZONTAL ANALOG SWITCH IC 49
A7 (100) FREQUENCY LATCH IC 37, 40
A8 (100) DATA MUX IC 35, 42
A9 (100) DIGITAL MEMORY IC 45, 46
A11 (100) SWEEP GENERATOR IC 33, 34, 44
A10 (100) VERTICAL D/A IC 38, 47
A13 (300) BLANKING DETECTOR IC 39, 41, 43
A12 (100) HORIZONTAL D/A IC 31, 48
A21 (300) TWIST COIL DRIVER Q9, Q10
CRT
A19 (300) HORIZONTAL AND VERTICAL DEFLECTION AMPLIFIERS IC 1, 2
A20 (300) CRT BIASING & BLANKING CIRCUITRY IC 3
A3 (200) REFERENCE VOLTAGE SUPPLIES IC 1, IC 2 (2, 3, 1)
A2 (200) LOGIC SUPPLY IC 2 (5, 6, 7)
A1 (200) DUAL TRACKING REGULATOR IC 3
A22 (400) SWITCHING SUPPLY IC 1
DISPLAY 5V
DISPLAY GND
+190 Vdc
-2.0 KVdc
6.3 Vac
+6.56V
+6.0V
-6.0V
+5V
+10V
-10V
SI
+6V REF
+15V
-15V
SIG GND
IN
OUT
DI
DO
8

MODEL 3980 BLOCK DIAGRAM

THEORY OF OPERATION
MODEL 3980
CRT DISPLAY

A. Linear Power Supplies A1, A2, A3 (200)

The supply voltages used to power the low voltage analog and digital circuitry is located on the 200 board. These supplies use the +15 V and -15 V power leads from a basic unit vertical plug-in module connector. The module and its supplies are activated by the front panel switch S1 applying the 6 V reference voltage from the mother board to the reference input to the supplies. The analog parts, such as operational amplifiers, are powered from a ±10 Vdc dual tracking regulator which utilizes both sections of IC3. The series pass element for the +10 V supply is Q2 (2N4401) and the pass element for the -10 V supply is Q3. The +10 V supply is referenced to +6 V through R12 and R14, and the -10 V supply is made to track the +10 V supply by R17 and R18.

The digital logic is powered by a +5 V supply which draws from the +15 V mother board lead. The 6 V reference voltage is divided down to 5 V by R7 and R8 and IC2 (5, 6, 7) acts as a current buffer to supply the bare current to the heat sink mounted series pass element Q1 (2N5190). The input scaling circuits and the CRT positioning controls require stable ±6 V voltages which are provided from the 6 V reference mother board lead through operational amplifier current buffers of IC1. One section is operated in the non-inverting mode for the +6 V and the other in the inverting mode for -6 V. Also a 2.560 V reference supply using IC2 (2, 3, 1) is provided to supply the reference for the Digital to Analog converters located on the 100 board. The supply is trimmed to the currect voltage with R5.

B. Analog Input Scaler A4 (100)

The voltage range of the analog signals being displayed are normalized to a range of 0 V to 2.56 V for a full-scale deflection on the CRT display by the analog input scaler section. This circuitry also responds to the range toggle switch on the right side of the M3980 front panel to provide a variety of display ranges. The analog signals translated by this section are the DB ANLG (pin F), DELAY ANLG (pin 13), and FREQ ANLG (pin J) signals from the basic unit mother board.

The scaling required for the FREQ ANLG line is simply a resistive divider made up of R10 and R11 which translates the 0 -8 V signal on the mother board to a 0 -2.56 V normalized signal which is then buffered by IC50 (5, 6, 7) (4558). The diodes D3 and D4 (5082-2835) clamp the normalized voltage to prevent wide excursions beyond the normal limits of 0 V and 2.56 V.

The DELAY ANLG signal is displayed only during 6.0 MS and 1.5 MS scales, so that there are two possible gain settings in the input scaler. In the 6.0 MS scale, R2 and R3 divide the DELAY ANALG signal, and in the 1.5 MS scale, R3 is no longer grounded and no attenuation is provided. The signal is then buffered and amplified by IC26 (5, 6, 7) (4558). The offset 0 delay position on the graticule is generated by the summing network R7, R8 and R9. The signal is clamped by D1 and D2, and then buffered by IC26 (2, 3, 1).

The DB ANLG signal has three scales associated with level. The switching of the scale use IC25 (4066) to select the gain necessary as defined by the position of S10. The offset for the 0 dB line on the graticule is provided by R46 for the ±10 dB and ±4 dB scales and by R46 in parallel with R45 when S10 is in the +10/-70 scale position. This signal is then clamped by D5 and D6 (5082-2835) and buffered by IC50 (2, 3, 1) (4558).

C. Digital Storage General Description

The digital storage function of the Model 3980 is composed of Blocks A5 through A14. There are two concurrent independent functions occurring in the storage section; they are the continuous display of stored data, and the storage of new data. The data display simply functions by stepping up through the memory from one address to the next until the highest address is reached and then stepping down back down until the lowest address is reached and repeating. This sweep is performed at a rate of about 61 Hz so that the display appears continuous to the eye.

The memory storage of new data is accomplished with an Analog-to-Digital (A/D) converter which converts the normalized analog signal from block A4 to 8 bit binary codes representing the analog voltage.

The memory has an 8 bit address bus and an 8 bit data bus for a total of 2,048 bits. The address field represents the frequency (horizontal) axis and the data field represents the amplitude and delay (vertical) axis. The memory is loaded by first converting the FREQ ANLG signal, this 8 bit code is latched and applied to the address bus. If the frequency binary code is even, then the DB ANLG signal is converted and the 8 bit code is applied to the digital memory input and is stored at the address previously latched. If the frequency binary code is odd, then DELAY ANLG is applied to the A/D converter and the resulting 8 bit code is stored in the odd address. The time required to store the data into the memory is very short (several microseconds) so that the storage can be accomplished during a blanking period of the display cycle and therefore not be noticeable on the CRT. A more detailed description of the individual functional blocks of this section follows.

D. A/D Analog Switch A5 (100)

The normalized (0 V to 2.56 V) analog signals from the mother board are connected to IC27 (4066). The transmission gates of IC27 are used to apply the analog voltage to the input of the A/D converter. During the first part of every cycle, IC27 pin 6 high, the frequency signal is activated; during the second part, either IC27 pin 13 for DB ANLG or pin 5 for DELAY ANLG depending on the least significant bit of the frequency conversion. The logic which makes this decision is composed of IC23, IC24 (12, 13, 11) and IC21 (3, 4).

E. Analog-to-Digital Converter A6 (100)

The normalized analog input signals are converted to 8 bit binary codes by a successive approximation register converter. The converter is composed of an input buffer (IC28), a comparator (IC22), a successive approximation register (IC36), and a Digital-to-Analog (D/A) converter (IC30). The converter basically functions by determining the 8 bit binary code which when converted to an analog current by the D/A converter, best cancels the current generated by the input buffer amplifier (IC28) and R12. The current summing point, TP4, is clamped around ground by the schottky diodes D15 and 16. For

a more thorough description of the CMOS successive approximation register operation, refer to a data sheet for a 4549.

The converter is aligned by removing IC27, inputing a full scale minus 1/2 least significant bit (5 mV), 2.555 V and then trimming R19 for the transition of the converted code from FFFE to FFFF. Next a 0 V + 1/2 LSB, 0.005 V is input and then R16 is trimmed for the transition from 0001 to 0000. These two adjustments interact, and therefore must be repeated several times. The required alignment voltages are provided by a resistive divider composed of R94, R95 and R96. Test point TP2 is 2.555 V and TP3 is 0.005 V.

The converter converts every 128 microseconds initiated by a pulse on IC36 pin 4, Start Convert. The End of Conversion pin 11 is used to latch the frequency digital byte. The output of the converter, 8 binary data bits, is applied to the D inputs of the frequency latch (A7) and to the Data In pins of the two memories. The frequency latch is composed of two quad latches IC37, 40 (4042).

F. Sweep Generator A11 (100)

The data in the memory must be constantly read out to allow the stored trace to appear continuously. To accomplish this, a pair of cascaded 4 bit up/down counters are utilized. The resulting 8 bit counter is controlled by a D flip-flop, IC33 (9, 11, 12) (4013), which changes the up/down control when the counter is about to under or overflow. The counter is clocked by a signal with a 32 microsecond period on IC34, 44 pin 15. The preset enable and preset data inputs are all commoned and tied to TP7 and a resistor R75 to ground. Connecting TP7 to +5 V causes all the counter outputs to be ones. This permits the adjustment to the horizontal D/A converter (A12) IC31, 48. This D/A converter supplies the horizontal sweep waveform to the CRT.

The constantly counting up and down 8 bit number is transformed into a triangle wave on the output of the horizontal D/A converter. This 8 bit number is also applied to the Data MUX (A8), IC35, 42. This multiplexer is composed of two 4 bit data selectors (4519) which most of the time connect the sweep generator 8 bit number to the memory address leads for readout of the stored data. However, after the A/D

converter converts frequency, latches it, and converts DB ANLG or DELAY ANLG, the data MUX is momentarily switched to the latched frequency representing the address where the converted level or delay data is to be stored.

G. Digital Memory A9 (100)

The storage of the DB ANLG and DELAY ANLG signals is performed by two 1024 bit 2101 NMOS memories. They are equipped with independent data inputs and data outputs. This allows the A/D converter to be wired directly to the data inputs and the vertical D/A converter (A10) wired directly to the data outputs. Also the memory has three state outputs which when disabled by tying TP5 to +5 V allow adjustment of the vertical D/A converter (IC38, 48) with all inputs high. To store new data the R/$\overline{W}$ input pin 20 of the memories is pulsed low for one microsecond while the input data is valid and the data MUX is switched to the latched frequency.

H. Horizontal Analog Switch A15 (100) and Vertical Analog Switch A16 (100)

In order to display the input signals versus the input frequency as well as the stored traces, the horizontal and vertical analog switches periodically connect the scaled input signals directly to the CRT deflection amplifiers for display. The scaled FREQ ANLG signal is connected to the Horizontal Analog Switch IC49 pin 4. The scaled DB ANLG signal is connected to the vertical analog switch IC20 pin 4 and DELAY ANLG to IC20 pin 8. Both of these analog switches also have an input which is activated when the toggle switch on the left side of the M3980 is in X-Y. During the time that the switch is in X-Y, the horizontal channel is connected to an input scaling and clamping network composed of R66, 67, 68, and D11, 12. The vertical channel is connected to a similar circuit composed of R69 70, 71 and D13, 14. These scaling circuits are connected to the outputs of the Bar-Graph Generator A17 (500). The outputs of the horizontal and vertical analog switches go directly to the CRT deflection amplifiers on 300 board.

I. Blanking Circuitry A13 (100) and Front Panel Switch Logic A18 (100)

Besides the horizontal and vertical signals from the analog switches, the CRT also needs a signal which blanks the CRT beam during the time

that the deflection amplifiers are slewing from one trace to another. Also to prevent incorrect data from being displayed when the input signal exceeds the normalized range, the bottom-most, right-most, and top-most digitally stored points are blanked. This is accomplished by IC41 (4078) for the bottom, IC43 (4068) for the top, and IC39 (4068). These signals are "ored" in IC18 (3, 4, 5, 6) (4023) and then summed with the other blanking signals and applied to a transistor Q2 on the 300 board which capacitively couples (C7) the blanking signal to the control grid of the CRT (pin 3) at a potential of -2.0 kV.

The other blanking signals are generated by the front panel switch control logic. The switches labelled "DISPLAY" on the front panel are used to blank or unblank the amplitude, delay, or input traces. The front panel switch control logic also controls storage of data in the memories (S4 and S8) and also permits the memories to be cleared to all zeroes. When the memories are cleared to all zeroes, the display appears blank due to IC41 as mentioned above. The memory clear is accomplished by switches S5 and S9 and IC1, 2, and 8. A dual flip-flop, IC2 (4013), synchronizes a cycle of the horizontal sweep, IC44 pin 2, and holds the DATA IN of the memories to zero by holding the master reset (IC36 pin 10) of the A/D converter active. During this period store pulses are applied to the R/$\overline{W}$ pin of the 2101 memories.

J. Clock Generator A14 (100)

The operation of the A/D converter, the sweep generator, the memory storage, and the analog switch control, all are synchronous functions which are driven by a clock and timing pulse generator. The reference clock frequency is 1 MHz obtained from the mother board pin $\overline{L}$. The 1 MHz signal is divided by two by IC19 (3, 5, 2) (4013) and then by a dual four bit binary counter IC14 (4520). Note that the clock string is interrupted by switching the toggle switch on the left side of the M3980 front panel to "X-Y." The outputs of the counters are then combined to form specific timing pulses. The pulse used to strobe the R/$\overline{W}$ pin of the memories is generated by IC5 (3, 4) and IC7 (3, 4, 5, 6), and it is of one microsecond duration. The signal which switches the system from display to memory store every 256

microseconds is generated by IC17 (9, 8), IC18 (11, 12, 13, 10), IC13 (1, 2, 3), IC17(11, 10), and IC13 (5, 6, 4). Also, the latch strobe for the frequency latch A7 is generated by IC7 (11, 12, 13, 10), IC5 (1, 2), and IC6 (1, 2, 3).

K. Horizontal and Vertical Deflection Amplifier A19 (300)

The video signals from the horizontal and vertical analog switches are applied to the CRT deflection amplifiers. The deflection amplifiers are differential pair amplifiers whose outputs are connected to the horizontal and vertical deflection plates of the CRT. The horizontal deflection amplifier is composed of IC1 (2, 3, 1) (4558), IC2 (2, 3, 1) (4558), Q7, and Q8 (MPS-A-42). The operational amplifiers provide a high impedance input to the differential amplifier. A 5 milliampere current source composed of Q6, R20, R21, R22 and D6 provides a constant current for the differential pair. The amplifier gain is adjusted by R13 and the position is controlled by the divider R5, R4, and R11 which is referenced to the stable ±6 V supplies. The collector supply for the amplifier is powered by the 190 V dc output from the switching supply on the 400 board. The vertical deflection amplifier is of the same configuration, however, the gain is about half due to the greater vertical deflection sensitivity of the D14-251 GH CRT.

Also contained on the Deflection Amplifier board is the high voltage divider circuit which together with the potentiometers for intensity and focus provides the correct biasing for CRT operation. The intensity control varies the negative bias on the control grid (pin 3) which is about 60 volts below the cathode (pin 7) and filiament (pins 1 and 14) potential. An optical coupler IC3 (4N25) is activated by Q1 (2N4401) when in the "X-Y" mode, and shifts the grid bias so that no adjustment of the intensity control is required when the blanking circuit of the digital storage section is idle.

Due to manufacturing tolerances in the CRT face and deflection plates, it is necessary to provide an electric field to counter act any axial misalignment. A twist coil is driven by Q9 or Q10 and supplies the current adjusted by R43. The twist coil is located around the neck of the tube.

L. Switching Supply A22 (400)

The switching supply on the 400 board provides the acceleration potential, the filiament voltage, and the deflection amplifier power for the operation of the CRT. The input power to the switching supply is obtained from the DISPLAY 5 V from the mother board. The heart of the switching supply is the pulse-width modulating switching regulator, IC1 (SG3524). This integrated circuit provides the 40 kHz oscillator, error amplifier, reference voltage, and push-pull driver stage. The collectors of the driver transistors inside IC1 drive the base current supplies for the high power switching transistors which are connected to the transformer T1. When IC1 pin 12 goes low, it turns on Q1 which applies bare current to Q3 and turns off Q2. When IC1 pin 12 goes high, Q2 is turned on and it quickly removes the carriers in Q3's base region, permitting it to switch off quickly. An identical driver is used for Q4 and IC pin 13. The transformer primary center tap has the filtered 5 V DISPLAY applied to it.

On the secondary there are three windings, a 190 V winding, 500 V winding and a 6.3 V winding. The 190 V winding is applied to a bridge rectifier composed of D12, 13, 14, 15, and filter L2, C26, and C27. The 190 volt output is scaled by R21, 22, and 23 and fed back to the inverting input (pin 1) of the error amplifier in IC1. Therefore, IC1 regulates the 190 output to the deflection amplifiers and the other two supplies track. The 6.3 V winding on T1 is used to supply filiament voltage to the CRT and is on 20 kHz square-wave AC voltage.

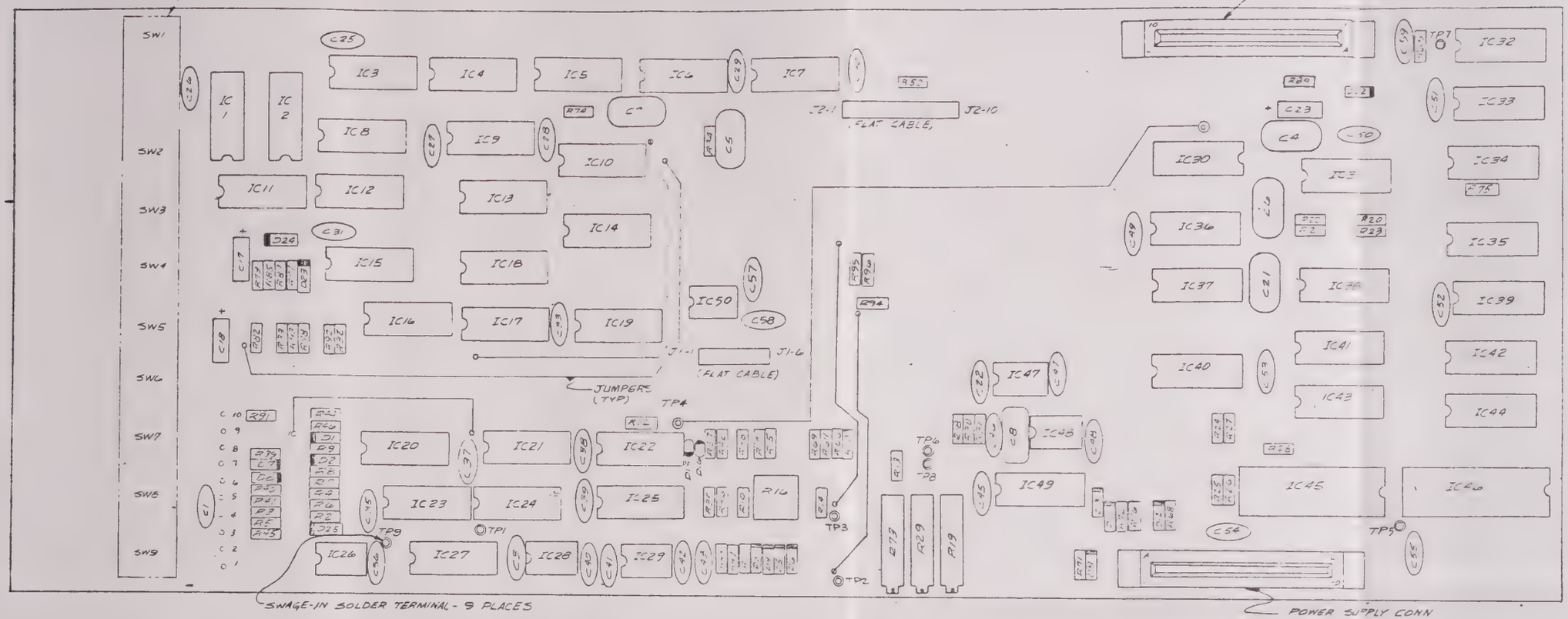
The 500 V winding on T1 is connected to a four-stage Cockcroft-Walton voltage multiplier composed of C18, 20, 22, 24 and D16, 17, 18, 19. The resulting -2.0 kV dc voltage is filtered through L3 and C28 and then routed to the 300 board where it provides the biasing and acceleration potential for the CRT.

M. Bar-Graph Generator A17 (500)

The Bar-Graph Generator located on the 500 board generates a horizontal and a vertical signal for connection to the respective deflection amplifiers. The horizontal signal is generated by the switching of IC1 (3, 4, 5) between +6 V and -6 V at a 1 kHz rate supplied by IC2 (5, 6,

7). The signal is scaled by R5 and R6, and capacitively coupled by C5. The resulting waveform causes the CRT beam to switch back and forth between the positions on the graticule marked PHASE P^{O} and AMP %.

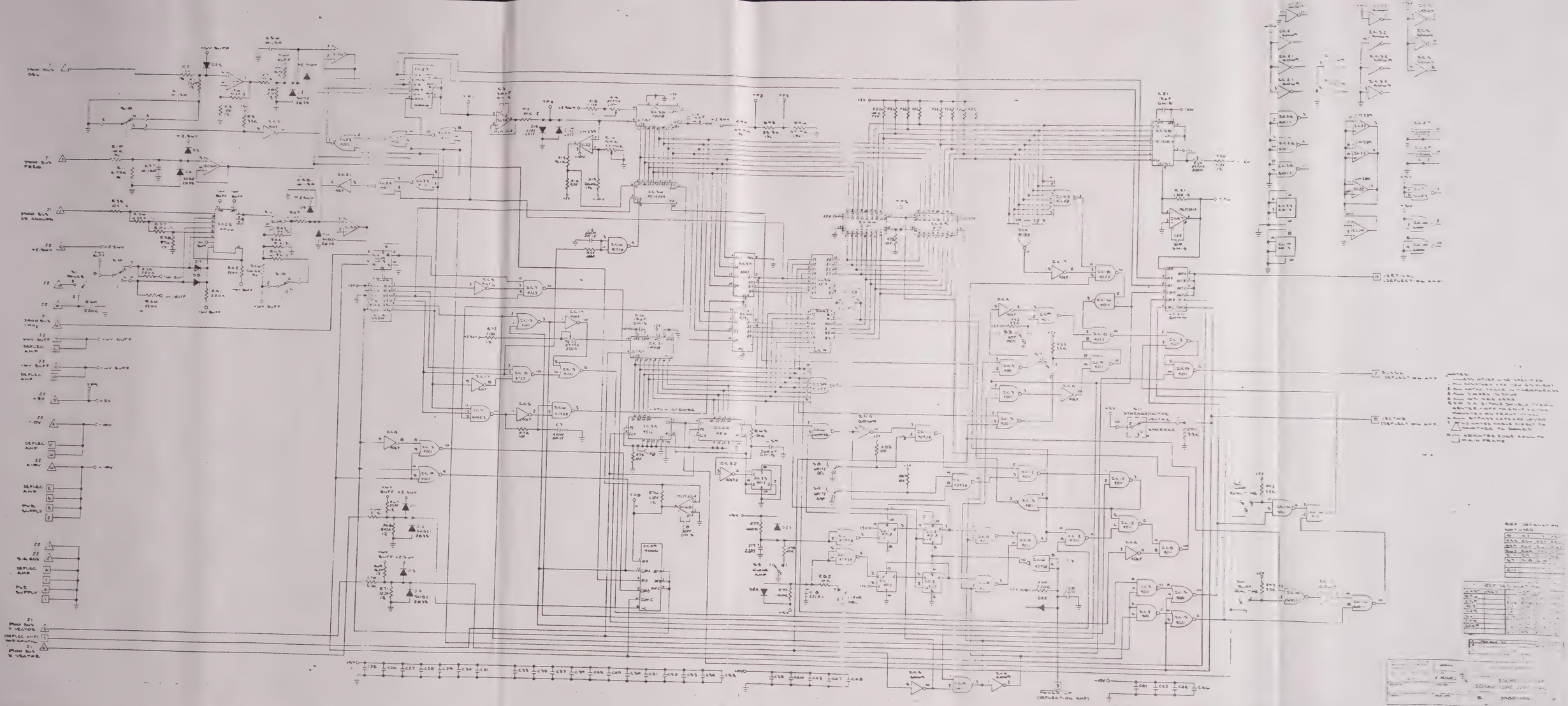
The vertical channel signal is generated by switching the PH JIT ANLG motherboard signal on the AMP JIT ANLG signal into the summing junction of IC2 (2, 3, 1) through input resistors R1 or R2 and IC1 (1, 2, 15) or IC1 (12, 13, 14). The amplitude of the signal is scaled by R3 and capacitively coupled to the vertical input network (see Section H).



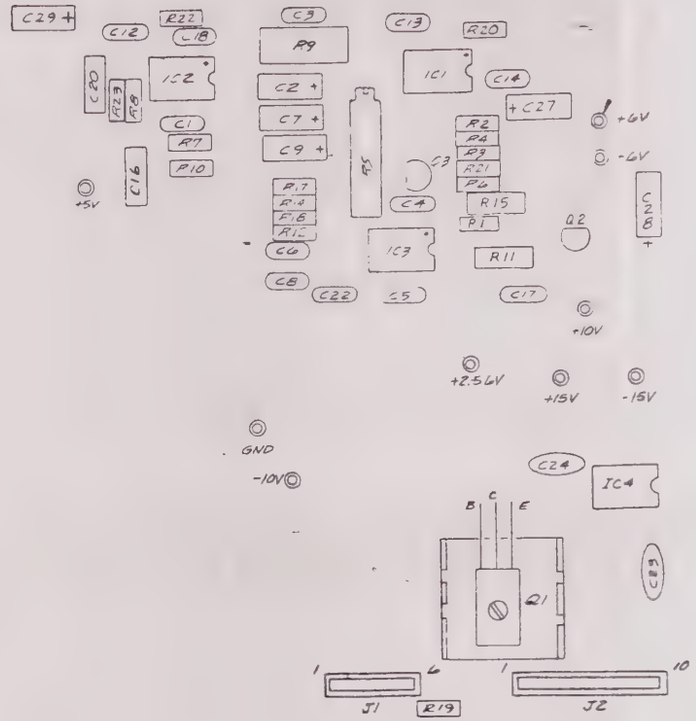
NOTES:

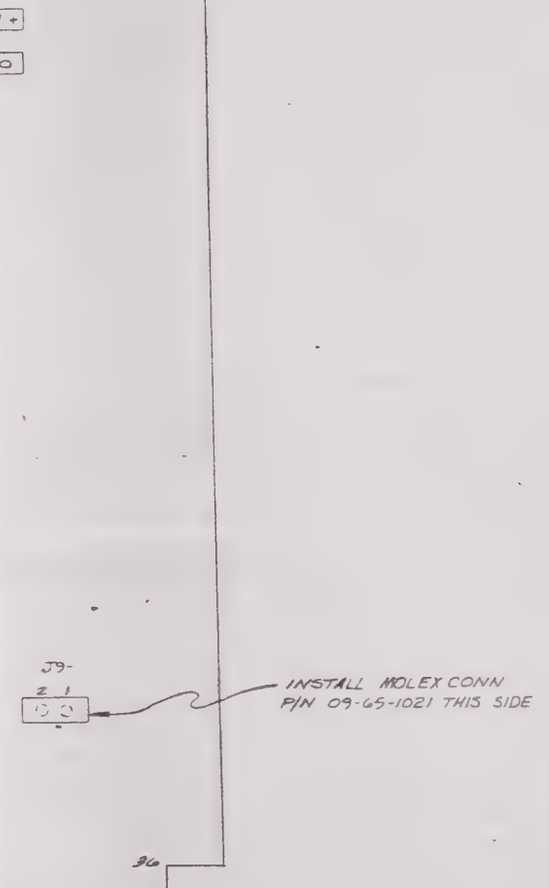
1. C26 THRU C55 ARE .01/50V BYPASS CAPS

ASSY, LOGIC P.C BOARD
MODEL 3980-101



— INSTALL SWAGE IN SOLDER TERRET - TYP





NOTES:

1) C12 THRU C18 ARE .01/50V BYPASS CAPS

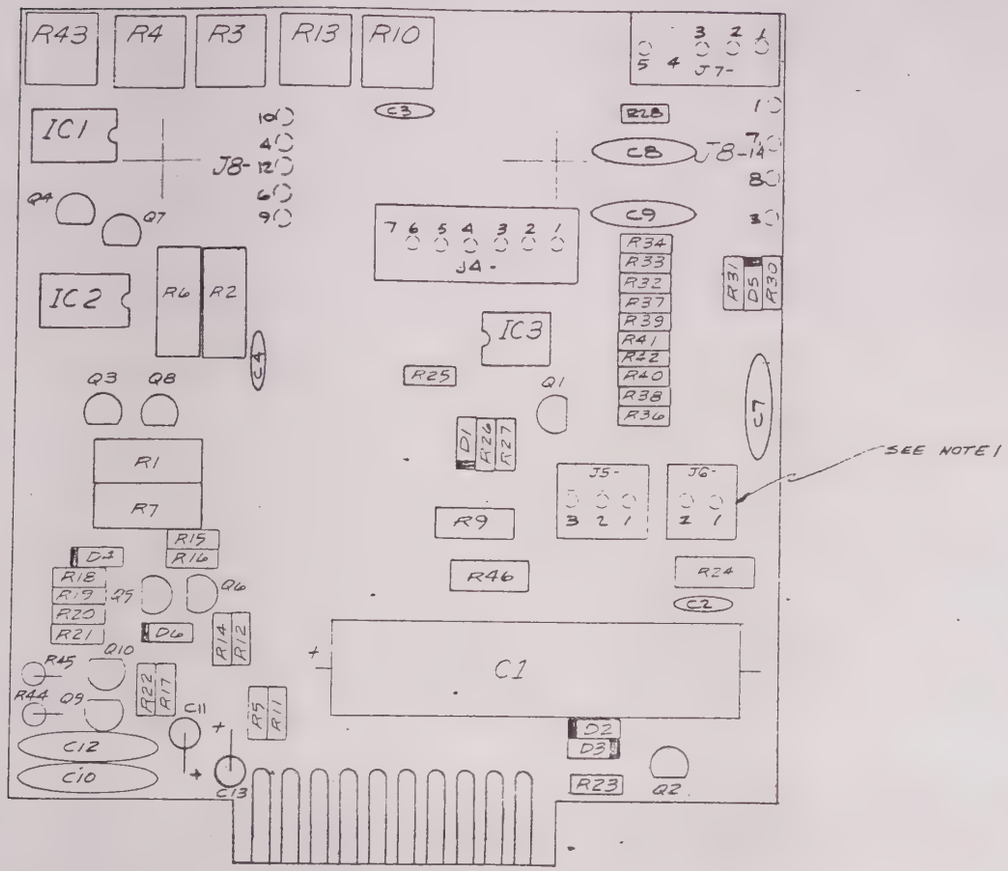
D	ECO1222 - REMOVE C25 & C26	2-8-78	DFG

DFG 27 DEC '76

ASSY, INTERFACE P.C. BOARD
MODEL 3980-201

D 3980-203 D

2/1



NOTES:

1- ALL MOLEX CONNECTORS (J4, J5, J6, & J7) INSTALL W/ LOCKING TAB ORIENTED AWAY FROM THE EDGE CONN

REV	DESCRIPTION	DATE	APPR
	REVISIONS		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE
FRACTIONAL ± DECIMALS ANGLES
.XX ± ~ ±
.XXX ± ~ ~

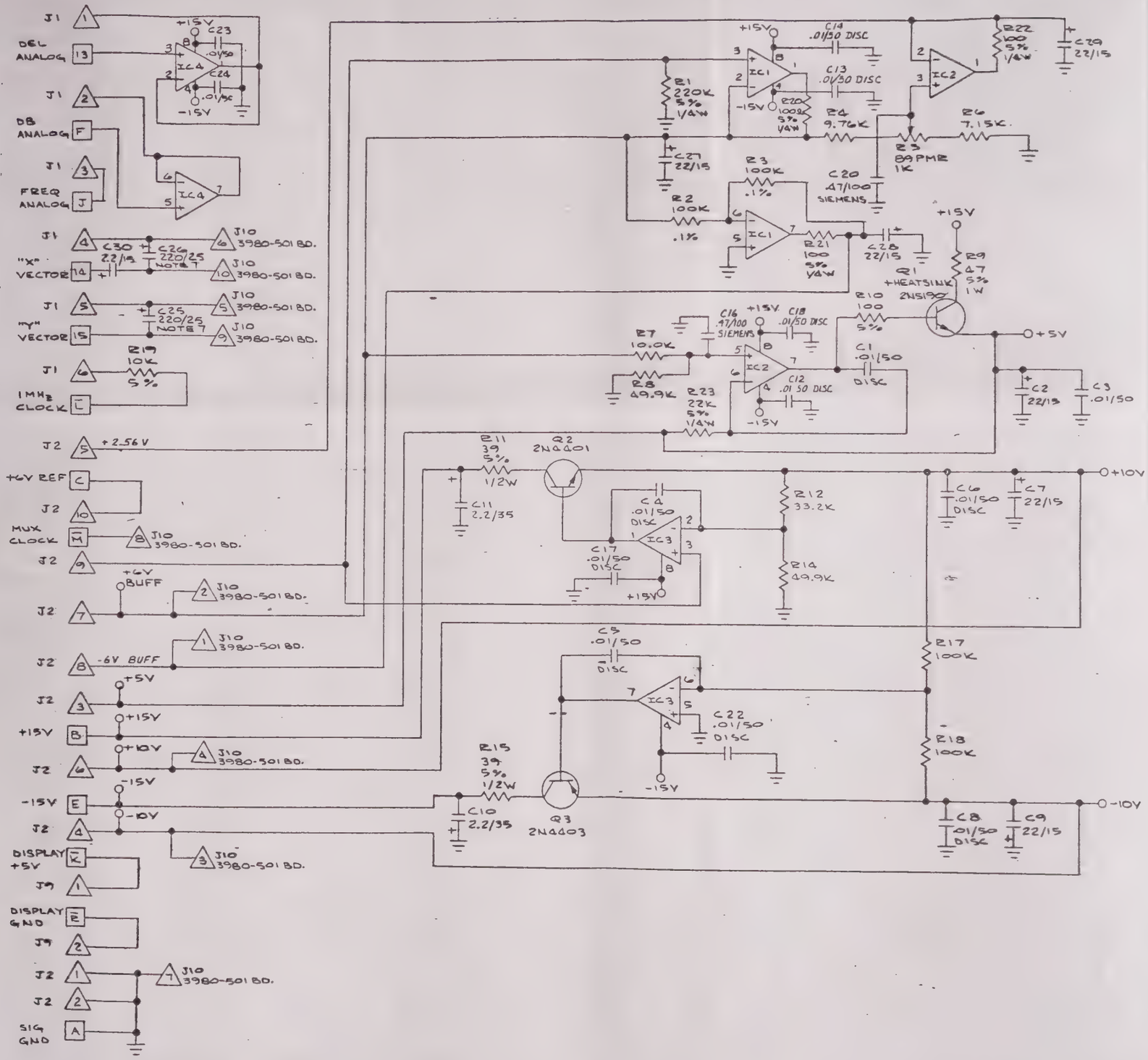
	APPROVAL	DATE
	DRAWN GEP	5-9-77
MATERIAL ~	CHECKED	
FINISH ~	ENGR APPR	

HEKIMIAN LABORATORIES INC.
COMMUNICATION SYSTEMS, CIRCUIT INSTRUMENTATION

TITLE ASSY, P.C. BOARD DEFLECTION AMP

SIZE	DWG NO.	REV
C	3980-303	C

SCALE 2:1 SHEET 1 OF 1



NOTES:
UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTORS ARE 1% 2N55D
2. ALL CAPACITANCE IN MICROFARADS
3. ALL DIODES ARE IN3064
4. ALL O/A ARE 4558
5. □ INDICATES EDGE CONN TO MAIN FRAME
6. △ INDICATES CABLE DIRECT TO ANOTHER P.C. BOARD
7. C25 AND C26 ARE NOT NORMALLY USED. FOR OPTION #1 DELETE THE 3980-501 BOARD AND C30; CONNECT A JUMPER WIRE IN PLACE OF C30 AND ADD C25 AND C26. SEE DRAWING #3980-50 FOR THE SCHEMATIC OF THE 3980-501 BOARD.

REF DESIGNATION					
LAST USED		NOT USED			
R23		C21	C19	R16	
C30		C15	R13		
Q3					
IC4					

G-1	PER ECO 644	1-31-79
G	PER ECO 222	3-9-78
F	PER ECO-154	11-12-77
E		6-15-77

			SCHEMATIC DIAGRAM MODEL 3900 INTERFACE BOARD
	DKA	2/28/77	
		4/14/77	D 3980-204 G-1
			NONE

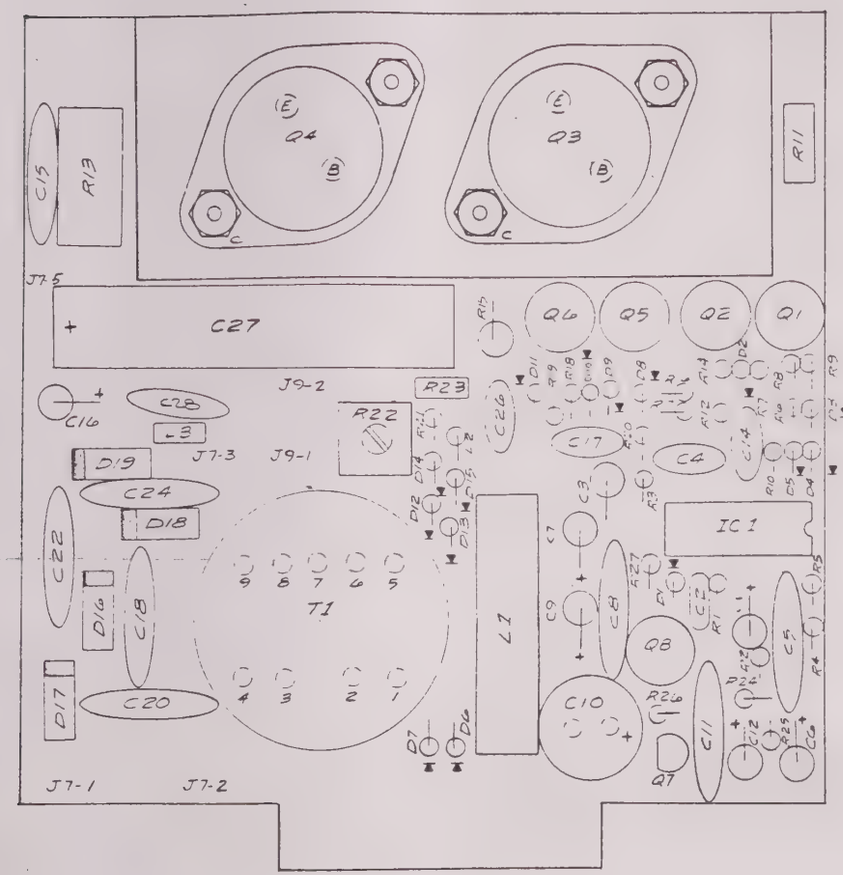
REF DESIGNATION				
LAST USED		NOT USED		
C18		C5	C6	C14
R46		C15		
Q10		C16		
IC2		C17		
D6		C18		

NOTES:

UNLESS OTHERWISE SPECIFIED:

1. ALL RESISTORS ARE 1/4 WATT, 5%
2. ALL CAPACITANCE IN MICROFARADS
3. ALL O/A ARE 4558
4. △ INDICATES CABLE DIRECT TO ANOTHER P.C. BOARD
5. ○ INDICATES CABLE DIRECT TO CRT SOCKET
6. □ INDICATES EDGE CONN. TO MAIN FRAME

	F.M.B	9/19/77	SCHEMATIC DEFLECTION AMPLIFIER BOARD
	JFK	9/14/77	
	DMT	9/19/77	D 3980-304 G1



NOTES:

1. Q1, Q2 Q5, Q6, & Q8 ARE INSTALLED WITH A TRANSISTOR PAD UNDERNEATH.
2. L1 & R13 ARE MOUNTED SLIGHTLY RAISED ABOVE P.C. BOARD SURFACE

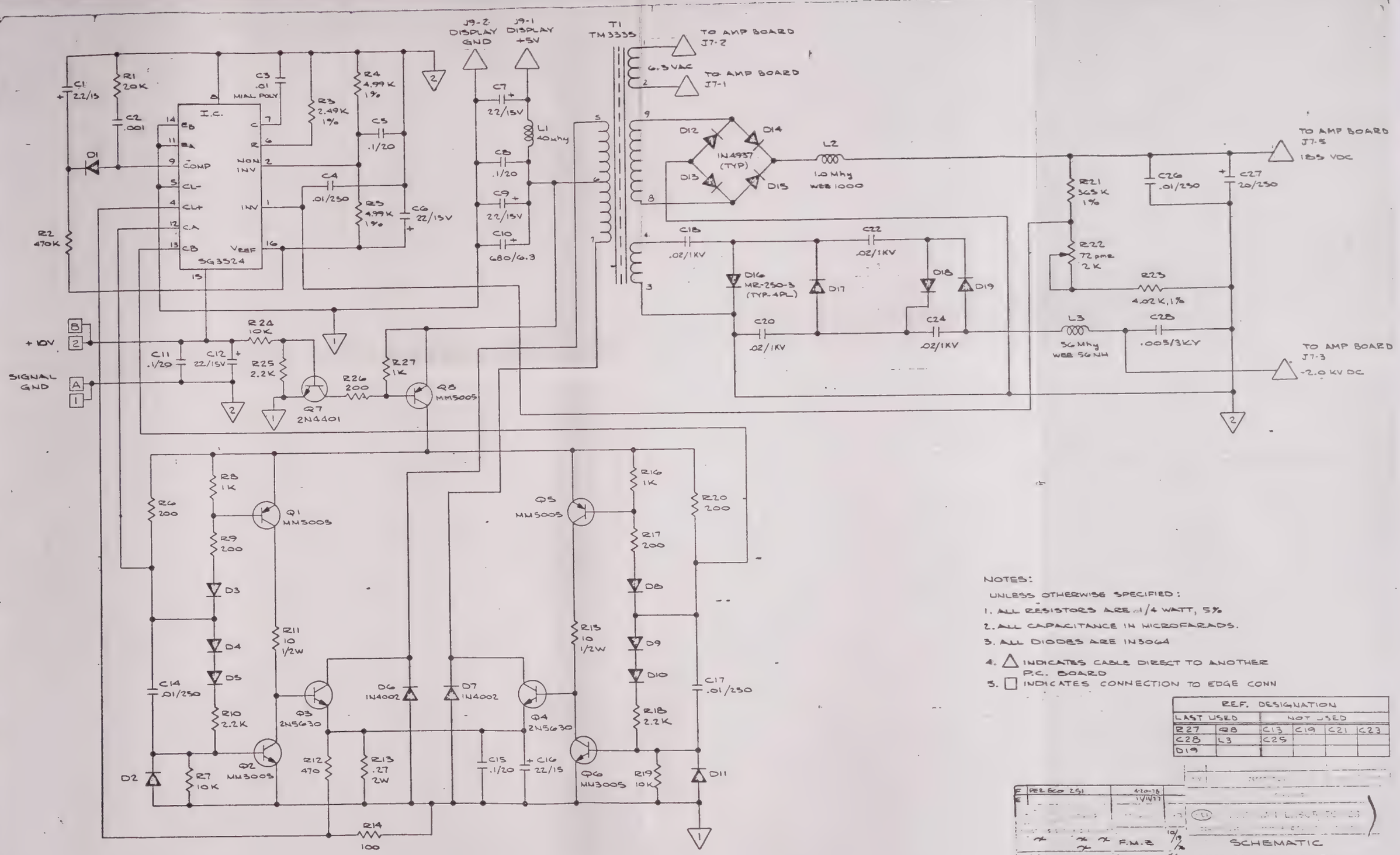
GEP 5-12-77

ASSY, PWR SUPPLY BOARD

MODEL 3980-400

C 3980-403 C

2:1



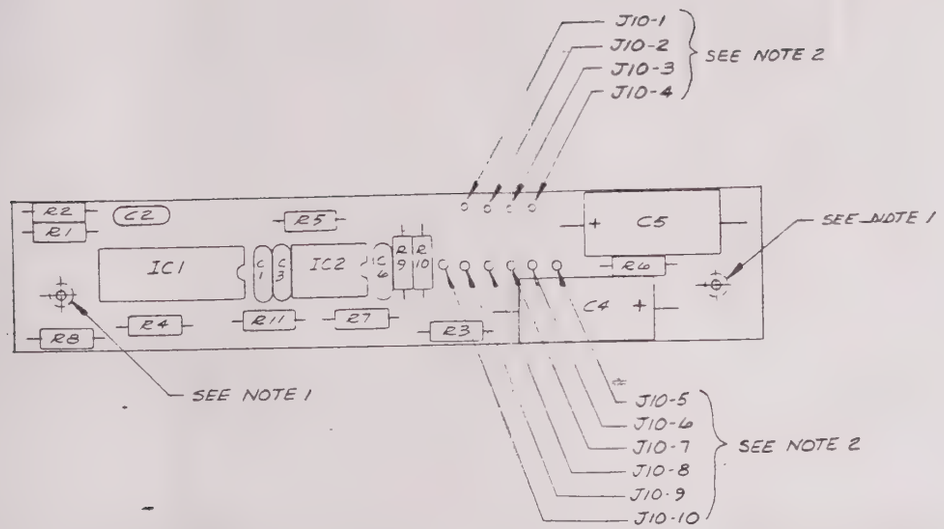
NOTES:

UNLESS OTHERWISE SPECIFIED:

1. ALL RESISTORS ARE 1/4 WATT, 5%
2. ALL CAPACITANCE IN MICROFARADS.
3. ALL DIODES ARE IN3064
4. △ INDICATES CABLE DIRECT TO ANOTHER P.C. BOARD
5. □ INDICATES CONNECTION TO EDGE CONN

REF. DESIGNATION					
LAST USED		NOT USED			
R27	Q8	C13	C19	C21	C23
C28	L3	C25			
D19					

F	PER ECO 251	4-20-78		
E		11/14/77		
	F.M.Z	10/3/77	SCHEMATIC	
	JPG	9/19/77	CRT POWER SUPPLY	
	J.H.J.	9/14/77	D 3980-404	F



NOTES

1- INSTALL FROM FAR SIDE - .25 LG x .25 DIA x 4-40 THD SWAGE IN STANDOFF

2- INSTALL FROM THIS SIDE - 'SMALL' SWAGE IN SOLDER TURRET POST

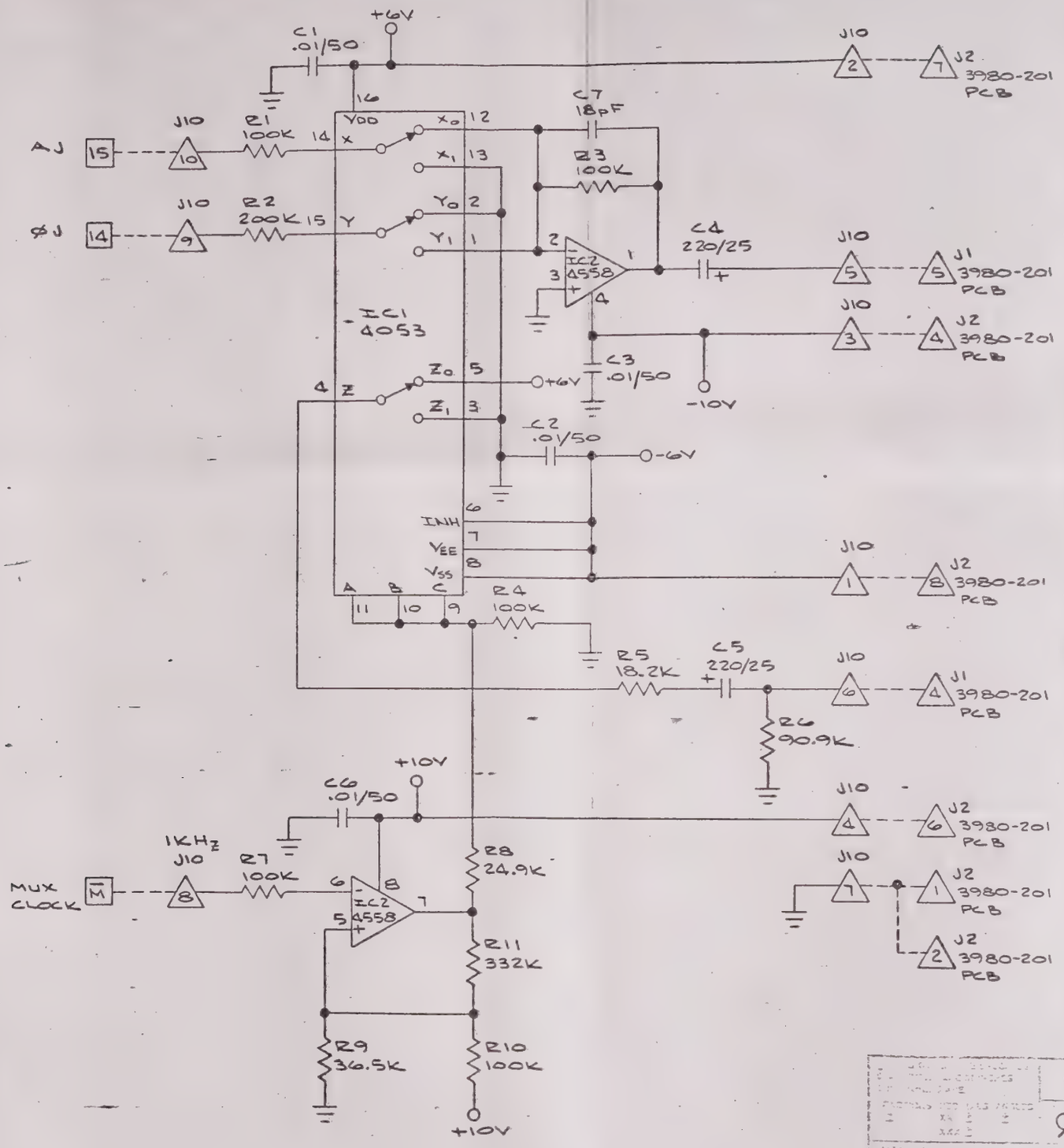
GOEPPER

2-7-78

ASSY, P.C. BOARD
BAR GRAPH MOD. BD. #3980-501

C 3980-503

2=1



NOTES:
UNLESS OTHERWISE SPECIFIED;
1. ALL RESISTORS ARE 1/4W, 1%
2. ALL CAPACITANCE IN MICROFARADS
3. □ INDICATES EDGE CONN. TO MAIN FRAME
4. △ INDICATES CABLE DIRECT TO ANOTHER P.C. BOARD

A-1	PER ECO 441	1-31-79	
A	PER ECO 377, 394	11-6-78	
-1	PER ECO 267	4-17-78	

SCHEMATIC DIAGRAM
BAR GRAPH MODULE

C 3980-504 A-1
NONE

MODEL 3980-104 CRT DISPLAY PARTS LIST

Ref. No.	Description	Part No.	Mfr.
C1	Capacitor, Ceramic Disc. .01 µfd, 50 V, 20%	UKS0-103	CRL
C2	Not Used		
C3	Capacitor, Dipped Mica, 30 pf	DM15-300J	Arco
C4	Capacitor, Dipped Mica, 15 pf	DM15-150J	Arco
C5	Capacitor, Dipped Mica, 200 pf	DM15-201J	Arco
C6	Capacitor, Dipped Mica, 15 pf	DM15-150J	Arco
C7	Capacitor, Dipped Mica, 470 pf	DM15-471J	Arco
C8	Capacitor, Dipped Mica, 30 pf	DM15-300J	Arco
C9	Not Used		
C10	Not Used		
C11	Not Used		
C12	Not Used		
C13	Not Used		
C14	Not Used		
C15	Not Used		
C16	Not Used		
C17	Capacitor, Tantalum, 2.2 µfd, 15 V	CS13BE225K	Kemet
C18	Capacitor, Tantalum, 2.2 µfd, 15 V	CS13BE225K	Kemet
C19	Not Used		
C20	Not Used		
C21	Capacitor, Dipped Mica, 15 pf	DM15-150J	Arco
C22	Capacitor, Dipped Mica, 30 pf	DM15-300J	Arco
C23	Capacitor, Tantalum, 2.2 µfd, 15 V	CS13BE225K	Kemet
C24	Not Used		
C25	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UKS0-103	CRL
C26	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UKS0-103	CRL
C27	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UKS0-103	CRL
C28	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UKS0-103	CRL
C29	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UKS0-103	CRL
C30	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UKS0-103	CRL
C31	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UKS0-103	CRL
C32	Not Used		
C33	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UKS0-103	CRL
C34	Not Used		
C35	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UKS0-103	CRL
C36	Not Used		
C37	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UKS0-103	CRL
C38	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UKS0-103	CRL
C39	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UKS0-103	CRL
C40	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UKS0-103	CRL
C41	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UKS0-103	CRL
C42	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UKS0-103	CRL
C43	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UKS0-103	CRL
C44	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UKS0-103	CRL
C45	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UKS0-103	CRL
C46	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UKS0-103	CRL
C47	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UKS0-103	CRL
C48	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UKS0-103	CRL
C49	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UKS0-103	CRL
C50	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UKS0-103	CRL
C51	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UKS0-103	CRL
C52	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UKS0-103	CRL
C53	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UKS0-103	CRL
C54	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UKS0-103	CRL
C55	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UKS0-103	CRL
C56	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UKS0-103	CRL
C57	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UKS0-103	CRL
C58	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UKS0-103	CRL
C59	Capacitor, Dipped Mica, 200 pf	DM15-201J	Arco
D1	Diode, Silicon	1N3064	TI
D2	Diode, Schottky	5082-2835	HP
D3	Diode, Silicon	1N3064	TI
D4	Diode, Schottky	5082-2835	HP
D5	Diode, Silicon	1N3064	TI
D6	Diode, Schottky	5082-2835	HP
D7	Diode, Silicon	1N3064	TI
D8	Diode, Silicon	1N3064	TI
D9	Not Used		
D10	Not Used		
D11	Diode, Silicon	1N3064	TI
D12	Diode, Schottky	5082-2835	HP
D13	Diode, Silicon	1N3064	TI
D14	Diode, Schottky	5082-2835	HP
D15	Diode, Schottky	5082-2835	HP
D16	Diode, Schottky	5082-2835	HP
D17	Not Used		
D18	Not Used		
D19	Not Used		
D20	Not Used		
D21	Not Used		
D22	Diode, Silicon	1N3064	TI
D23	Diode, Silicon	1N3064	TI
D24	Diode, Silicon	1N3064	TI
D25	Diode, Silicon	1N3064	TI
IC	Integrated Circuit, Digital, CMOS	CD4013BFX	RCA
IC2	Integrated Circuit, Digital, CMOS	CD4013BFX	RCA
IC3	Integrated Circuit, Digital, CMOS	CD4011BFX	RCA
IC4	Integrated Circuit, Digital, CMOS	CD4069BFX	RCA
IC5	Integrated Circuit, Digital, CMOS	CD4069BFX	RCA
IC6	Integrated Circuit, Digital, CMOS	CD4093BFX	RCA
IC7	Integrated Circuit, Digital, CMOS	CD4023BFX	RCA
IC8	Integrated Circuit, Digital, CMOS	CD4011BFX	RCA
IC9	Integrated Circuit, Digital, CMOS	CD4011BFX	RCA
IC10	Integrated Circuit, Digital, CMOS	CD4001BFX	RCA
IC11	Integrated Circuit, Digital, CMOS	CD4093BFX	RCA
IC12	Integrated Circuit, Digital, CMOS	CD4011BFX	RCA
IC13	Integrated Circuit, Digital, CMOS	CD4001BFX	RCA
IC14	Integrated Circuit, Digital, CMOS	CD4520BFX	RCA
IC15	Integrated Circuit, Digital, CMOS	CD4001BFX	RCA
IC16	Integrated Circuit, Digital, CMOS	CD4011BFX	RCA
IC17	Integrated Circuit, Digital, CMOS	CD4069BFX	RCA
IC18	Integrated Circuit, Digital, CMOS	CD4023BFX	RCA
IC19	Integrated Circuit, Digital, CMOS	CD4013BFX	RCA
IC20	Integrated Circuit, Digital, CMOS	CD4066BFX	RCA
IC21	Integrated Circuit, Digital, CMOS	CD4069BFX	RCA
IC22	Integrated Circuit, Op/Amp	LM339N	National
IC23	Integrated Circuit, Digital, CMOS	CD4001BFX	RCA
IC24	Integrated Circuit, Digital, CMOS	CD4011BFX	RCA

MODEL 3980-104 CRT DISPLAY PARTS LIST

Ref. No.	Description	Part No.	Mfr.
IC25	Integrated Circuit, Digital, CMOS	CD4066BFX	RCA
IC26	Integrated Circuit, Dual Op/Amp	RC4558P	TI
IC27	Integrated Circuit, Digital, CMOS	CD4066BFX	RCA
IC28	Integrated Circuit, Op/Amp	MLM301A	Motorola
IC29	Integrated Circuit, Dual Op/Amp	RC4558P	TI
IC30	Integrated Circuit, Digital, CMOS	CD1408BFX	RCA
IC31	Integrated Circuit, Digital, CMOS	CD1408BFX	RCA
IC32	Integrated Circuit, Digital, CMOS	CD4069BFX	RCA
IC33	Integrated Circuit, Digital, CMOS	CD4013BFX	RCA
IC34	Integrated Circuit, Digital, CMOS	CD4516BFX	RCA
IC35	Integrated Circuit, Digital, CMOS	CD4519BFX	RCA
IC36	Integrated Circuit, Digital, CMOS	CD4549BFX	RCA
IC37	Integrated Circuit, Digital, CMOS	CD4042BFX	RCA
IC38	Integrated Circuit, Op/Amp	MC1408L-B	Motorola
IC39	Integrated Circuit, Digital, CMOS	CD4068BFX	RCA
IC40	Integrated Circuit, Digital, CMOS	CD4042BFX	RCA
IC41	Integrated Circuit, Digital, CMOS	CD4078BFX	RCA
IC42	Integrated Circuit, Digital, CMOS	CD4519BFX	RCA
IC43	Integrated Circuit, Digital, CMOS	CD4068BFX	RCA
IC44	Integrated Circuit, Digital, CMOS	CD4516BFX	RCA
IC45	Integrated Circuit, Digital, CMOS	CD2101BFX	RCA
IC46	Integrated Circuit, Digital, CMOS	CD2101BFX	RCA
IC47	Integrated Circuit, Op/Amp	MLM301A	Motorola
IC48	Integrated Circuit, Op/Amp	MOM301A	Motorola
IC49	Integrated Circuit, Digital, CMOS	CD4066BFX	RCA
IC50	Integrated Circuit, Op/Amp	RC4558P	TI
Q1	Not Used		
Q2	Not Used		
Q3	Not Used		
R1	Not Used		
R2	Resistor, Fixed, 100 kΩ, 1%	RN55D	AB
R3	Resistor, Fixed, 33.2 kΩ, 1%	RN55D	AB
R4	Resistor, Fixed, 10.0 kΩ, 1%	RN55D	AB
R5	Resistor, Fixed, 33 kΩ, 1/4 W, 5%	RCR07	AB
R6	Resistor, Fixed, 41.2 kΩ, 1%	RN55D	AB
R7	Resistor, Fixed, 10.0 kΩ, 1%	RN55D	AB
R8	Resistor, Fixed, 12.7 kΩ, 1%	RN55D	AB
R9	Resistor, Fixed, 46.9 kΩ, 1%	RN55D	AB
R10	Resistor, Fixed, 10.0 kΩ, 1%	RN55D	AB
R11	Resistor, Fixed, 4.75 kΩ, 1%	RN55D	AB
R12	Resistor, Fixed, 1.30 kΩ, 1%	RN55D	AB
R13	Resistor, Fixed, 9.1 kΩ, 1/4 W, 5%	RCR07	AB
R14	Resistor, Fixed, 4.7 kΩ, 1/4 W, 5%	RCR07	AB
R15	Resistor, Fixed, 20.0 kΩ, 1%	RN55D	AB
R16	Resistor, Variable, 50 Ω	72PWR50Ω	Beckman
R17	Not Used		
R18	Resistor, Fixed, 1.18 kΩ, 1%	RN55D	AB
R19	Resistor, Variable, 200 Ω	89PWR200Ω	Beckman
R20	Resistor, Fixed, 10 kΩ, 1/4 W, 5%	RCR07	AB
R21	Resistor, Fixed, 10 kΩ, 1/4 W, 5%	RCR07	AB
R22	Resistor, Fixed, 10 kΩ, 1/4 W, 5%	RCR07	AB
R23	Resistor, Fixed, 10 kΩ, 1/4 W, 5%	RCR07	AB
R24	Resistor, Fixed, 10 kΩ, 1/4 W, 5%	RCR07	AB
R25	Resistor, Fixed, 10 kΩ, 1/4 W, 5%	RCR07	AB
R26	Resistor, Fixed, 10 kΩ, 1/4 W, 5%	RCR07	AB
R27	Resistor, Fixed, 10 kΩ, 1/4 W, 5%	RCR07	AB
R28	Resistor, Fixed, 10 kΩ, 1/4 W, 5%	RCR07	AB
R29	Resistor, Variable 200 Ω	89PWR200Ω	Beckman
R30	Resistor, Fixed, 1.18 kΩ, 1%	RN55D	AB
R31	Resistor, Fixed, 1.30 kΩ, 1%	RN55D	AB
R32	Resistor, Fixed, 33 kΩ, 1/4 W, 5%	RCR07	AB
R33	Resistor, Fixed, 33 kΩ, 1/4 W, 5%	RCR07	AB
R34	Resistor, Fixed, 100 kΩ, 1/4 W, 5%	RCR07	AB
R35	Resistor, Fixed, 10.0 kΩ, 1%	RN55D	AB
R36	Resistor, Fixed, 6.04 kΩ, 1%	RN55D	AB
R37	Resistor, Fixed, 3.01 kΩ, 1%	RN55D	AB
R38	Resistor, Fixed, 976 Ω, 1%	RN55D	AB
R39	Resistor, Fixed, 220 kΩ, 1/4 W, 5%	RCR07	AB
R40	Resistor, Fixed, 220 kΩ, 1/4 W, 5%	RCR07	AB
R41	Resistor, Fixed, 220 kΩ, 1/4 W, 5%	RCR07	AB
R42	Resistor, Fixed, 220 kΩ, 1/4 W, 5%	RCR07	AB
R43	Resistor, Fixed, 10.0 kΩ, 1%	RN55D	AB
R44	Resistor, Fixed, 1.91 MΩ, 1%	RN55D	AB
R45	Resistor, Fixed, 61.9 kΩ, 1%	RN55D	AB
R46	Resistor, Fixed, 46.4 kΩ, 1%	RN55D	AB
R47	Resistor, Fixed, 10.0 kΩ, 1%	RN55D	AB
R48	Not Used		
R49	Not Used		
R50	Resistor, Fixed, 220 kΩ, 1/4 W, 5%	RCR07	AB
R51	Not Used		
R52	Not Used		
R53	Not Used		
R54	Not Used		
R55	Not Used		
R56	Not Used		
R57	Not Used		
R58	Not Used		
R59	Not Used		
R60	Not Used		
R61	Not Used		
R62	Not Used		
R63	Not Used		
R64	Not Used		
R65	Resistor, Fixed, 10 kΩ, 1/4 W, 5%	RCR07	AB
R66	Resistor, Fixed, 12.1 kΩ, 1%	RN55D	AB
R67	Resistor, Fixed, 30.9 kΩ, 1%	RN55D	AB
R68	Resistor, Fixed, 8.95 kΩ, 1%	RN55D	AB
R69	Resistor, Fixed, 46.4 kΩ, 1%	RN55D	AB
R70	Resistor, Fixed, 13.3 kΩ, 1%	RN55D	AB
R71	Resistor, Fixed, 12.7 kΩ, 1%	RN55D	AB
R72	Resistor, Fixed, 1.18 kΩ, 1%	RN55D	AB
R73	Resistor, Variable, 200 Ω	89PWR200Ω	Beckman
R74	Resistor, Fixed, 10 kΩ, 1/4 W, 5%	RCR07	AB
R75	Resistor, Fixed, 10 kΩ, 1/4 W, 5%	RCR07	AB
R76	Resistor, Fixed, 1.30 kΩ, 1%	RN55D	AB
R77	Resistor, Fixed, 100 kΩ, 1/4 W, 5%	RCR07	AB
R78	Resistor, Fixed, 10 kΩ, 1/4 W, 5%	RCR07	AB
R79	Resistor, Fixed, 100 kΩ, 1/4 W, 5%	RCR07	AB
R80	Not Used		
R81	Not Used		

MODEL 3980-104 CRT DISPLAY PARTS LIST

Ref. No.	Description	Part No.	Mfr.
R82	Resistor, Fixed, 10 kΩ, 1/4 W, 5%	RCR07	AB
R83	Not Used		
R84	Not Used		
R85	Resistor, Fixed, 10 kΩ, 1/4 W, 5%	RCR07	AB
R86	Not Used		
R87	Resistor, Fixed, 10 kΩ, 1/4 W, 5%	RCR07	AB
R88	Not Used		
R89	Resistor, Fixed, 220 kΩ, 1/4 W, 5%	RCR07	AB
R90	Not Used		
R91	Resistor, Fixed, 33 kΩ, 1/4 W, 5%	RCR07	AB
R92	Resistor, Fixed, 33 kΩ, 1/4 W, 5%	RCR07	AB
R93	Resistor, Fixed, 33 kΩ, 1/4 W, 5%	RCR07	AB
R94	Resistor, Fixed, 49.9 Ω, 1%	RN55D	AB
R95	Resistor, Fixed, 25.5 kΩ, 1%	RN55D	AB
R96	Resistor, Fixed, 49.9 Ω, 1%	RN55D	AB
S1-S9	Switch Assembly	B3980-053	HLI

Ref. No.	Description	Part No.	Mfr.

MODEL 3980-204 CRT DISPLAY BOARD PARTS LIST

Ref. No.	Description	Part No.	Mfr.
C1	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UK50-103	CRL
C2	Capacitor, Tantalum, 22 µfd, 15 V	CS13BD226K	Kemet
C3	Capacitor, Ceramic Disc. .01 µfd, 50 V, 20%	UK50-103	CRL
C4	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UK50-103	CRL
C5	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UK50-103	CRL
C6	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UK50-103	CRL
C7	Capacitor, Tantalum, 22 µfd, 15 V	CS13BD226K	Kemet
C8	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UK50-103	CRL
C9	Capacitor, Tantalum, 22 µfd, 15 V	CS13BD226K	Kemet
C10	Capacitor, Tantalum, 2.2 µfd, 35 V	CS13BF225K	Kemet
C11	Capacitor, Tantalum, 2.2 µfd, 35 V	CS13BF225K	Kemet
C12	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UK50-103	CRL
C13	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UK50-103	CRL
C14	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UK50-103	CRL
C15	Not Used		
C16	Capacitor, Polycarbonate, .47 µfd, 100 V, 5%	B32541C-.47/5/100	Siemens
C17	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UK50-103	CRL
C18	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UK50-103	CRL
C19	Not Used		
C20	Capacitor, Polycarbonate, .47 ufd, 100 V, 5%	B32541C-.47/5/100	Siemens
C21	Not Used		
C22	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UK50-103	CRL
C23	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UK50-103	CRL
C24	Capacitor, Ceramic Disc, .01 µfd, 50 V, 20%	UK50-103	CRL
C25	Not Used		
C26	Not Used		
C27	Capacitor, Tantalum, 22 µfd, 15 V	CS13BD226K	Kemet
C28	Capacitor, Tantalum, 22 µfd, 15 V	CS13BD226K	Kemet
C29	Capacitor, Tantalum, 22 µfd, 15 V	CS13BD226K	Kemet
IC1	Integrated Circuit, Dual Op/Amp	RC4558P	TI
IC2	Integrated Circuit, Dual Op/Amp	RC4558P	TI
IC3	Integrated Circuit, Dual Op/Amp	RC4558P	TI
IC4	Integrated Circuit, Dual Op/Amp	RC4558P	TI
Q1	Transistor, Silicon	2N5190	Motorola
Q2	Transistor, Silicon	2N4401	Motorola
Q3	Transistor, Silicon	2N4401	Motorola
R1	Resistor, Fixed, 220 kΩ, 1/4 W, 5%	RCR07	AB
R2	Resistor, Fixed, 100 kΩ, 1%	RN55D	
R3	Resistor, Fixed, 100 kΩ, 1%	RN55D	AB
R4	Resistor, Fixed, 9.76 kΩ, 1%	RN55D	AB
R5	Resistor, Variable, 1.0 kΩ	89PMR1K	Beckman
R6	Resistor, Fixed, 7.15 kΩ, 1%	RN55D	AB
R7	Resistor, Fixed, 10.0 kΩ, 1%	RN55D	AB
R8	Resistor, Fixed, 49.9 kΩ, 1%	RN55D	AB
R9	Resistor, Fixed, 47 Ω, 1 W, 5%	RC32G	AB
R10	Resistor, Fixed, 100 Ω, 1/4 W, 5%	RCR07	AB
R11	Resistor, Fixed, 39 Ω, 1/2 W, 5%	RCR20G	AB
R12	Resistor, Fixed, 33.2 kΩ, 1%	RN55D	AB
R13	Not Used		
R14	Resistor, Fixed, 49.9 kΩ, 1%	RN55D	AB
R15	Resistor, Fixed, 39 Ω, 1/2 W, 5%	RCR20G	AB
R16	Not Used		
R17	Resistor, Fixed, 100 kΩ, 1%	RN55D	AB
R18	Resistor, Fixed, 100 kΩ, 1%	RN55D	AB
R19	Resistor, Fixed, 10 kΩ, 1/4 W, 5%	RCR07	AB
R20	Resistor, Fixed, 100 Ω, 1/4 W, 5%	RCR07	AB
R21	Resistor, Fixed, 100 Ω, 1/4 W, 5%	RCR07	AB
R22	Resistor, Fixed, 100 Ω, 1/4 W, 5%	RCR07	AB
R23	Resistor, Fixed, 22 kΩ, 1/4 W, 5%	RCR07	AB

Ref. No.	Description	Part No.	Mfr.

MODEL 3980-304 CRT DISPLAY BOARD PARTS LIST

Ref. No.	Description	Part No.	Mfr.
C1	Capacitor, Electrolytic, 20 µfd, 250 V	39D206F250EL4	Sprague
C2	Capacitor, Polycarbonate, .01 µfd, 250 V, 5%	B32541C-.01/5/250	Siemens
C3	Capacitor, Polycarbonate, .01 µfd, 250 V, 5%	B32541C-.01/5/250	Siemens
C4	Capacitor, Polycarbonate, .01 µfd, 250 V, 5%	B32541C-.01/5/250	Siemens
C5	Not Used		
C6	Not Used		
C7	Capacitor, Ceramic Disc, .005 µfd, 3 kV	30GA-D50	Sprague
C8	Capacitor, Ceramic Disc, .005 µfd, 3 kV	30GA-D50	Sprague
C9	Capacitor, Ceramic Disc, .005 µfd, 3 kV	30GA-D50	Sprague
C10	Capacitor, Ceramic Disc, 0.1 µfd, 20 V, 20%	UK20-104	CRL
C11	Capacitor, Tantalum, 22 µfd, 15 V	CS13BD226K	Kemet
C12	Capacitor, Ceramic Disc, 0.1 µfd, 20 V, 20%	UK20-104	CRL
C13	Capacitor, Tantalum, 22 µfd, 15 V	CS13BD226K	Kemet
C14	Not Used		
C15	Not Used		
C16	Not Used		
C17	Not Used		
C18	Not Used		
D1	Diode, Silicon	1N3064	TI
D2	Diode, Silicon	1N3064	TI
D3	Diode, Zener	1N5250B	Amperex
D4	Diode, Silicon	1N3064	TI
D5	Diode, Silicon	1N3064	TI
D6	Diode, Silicon	1N3064	TI
IC1	Integrated Circuit, Dual Op/Amp	RC4558P	TI
IC2	Integrated Circuit, Dual Op/Amp	RC4558P	TI
Q1	Transistor, Silicon	2N4401	Motorola
Q2	Transistor, Silicon	2N4401	Motorola
Q3	Transistor, Silicon	MPS-A42	Motorola
Q4	Transistor, Silicon	MPS-A42	Motorola
Q5	Transistor, Silicon	2N4401	Motorola
Q6	Transistor, Silicon	2N4401	Motorola
Q7	Transistor, Silicon	MPS-A42	Motorola
Q8	Transistor, Silicon	MPS-A42	Motorola
Q9	Transistor, Silicon	2N4401	Motorola
Q10	Transistor, Silicon	2N4403	Motorola
R1	Resistor, Fixed, 39.2 kΩ, 1 W, 1%	RN65D	AB
R2	Resistor, Fixed, 39.2 kΩ, 1 W, 1%	RN65D	AB
R3	Resistor, Variable, 5 kΩ	72PMR5K	Beckman
R4	Resistor, Variable, 5 kΩ	72PMR5K	Beckman
R5	Resistor, Fixed, 6.34 kΩ, 1%	RN55D	AB
R6	Resistor, Fixed, 39.2 kΩ, 1%	RN55D	AB
R7	Resistor, Fixed, 39.2 kΩ, 1%	RN55D	AB
R8	Resistor, Fixed, 25 kΩ, 1/4 W, 5%	RCR07	AB
R9	Resistor, Fixed, 11 kΩ, 1/2 W, 5%	RC20G	AB
R10	Resistor, Variable, 10 kΩ	72PMR10K	Beckman
R11	Resistor, Fixed, 10.0 kΩ, 1%	RN55D	AB
R12	Resistor, Fixed, 681 Ω, 1%	RN55D	AB
R13	Resistor, Variable, 10.0 kΩ	72PMR10K	Beckman
R14	Resistor, Fixed, 681 Ω, 1%	RN55D	AB
R15	Resistor, Fixed, 1.50 kΩ, 1%	RN55D	AB
R16	Resistor, Fixed, 1.50 kΩ, 1%	RN55D	AB
R17	Resistor, Fixed, 8.06 kΩ, 1%	RN55D	AB
R18	Resistor, Fixed, 280 Ω, 1%	RN55D	AB
R19	Resistor, Fixed, 1.40 kΩ, 1%	RN55D	AB
R20	Resistor, Fixed, 681 Ω, 1%	RN55D	AB
R21	Resistor, Fixed, 3.40 kΩ, 1%	RN55D	AB
R22	Resistor, Fixed, 6.04 kΩ, 1%	RN55D	AB
R23	Resistor, Fixed, 10 kΩ, 1/4 W, 5%	RCR07	AB
R24	Resistor, Fixed, 100 kΩ, 1/2 W, 5%	RC20G	AB
R25	Resistor, Fixed, 1.0 kΩ, 1/4 W, 5%	RCR07	AB
R26	Resistor, Fixed, 10 kΩ, 1/4 W, 5%	RCR07	AB
R27	Resistor, Fixed, 100 Ω, 1/4 W, 5%	RCR07	AB
R28	Resistor, Fixed, 274 kΩ, 1%	RN55D	AB
R29	Resistor, Fixed, 200 kΩ, 1/4 W, 5%	RCR07	AB
R30	Resistor, Fixed, 100 kΩ, 1/4 W, 5%	RCR07	AB
R31	Resistor, Fixed, 100 Ω, 1/4 W, 5%	RCR07	AB
R32	Resistor, Fixed, 100 kΩ, 1%	RN55D	AB
R33	Resistor, Fixed, 49.9 kΩ, 1%	RN55D	AB
R34	Resistor, Fixed, 422 kΩ, 1%	RN55D	AB
R35	Resistor, Fixed, 500 kΩ, 1/4 W, 5%	RCR07	AB
R36	Resistor, Fixed, 499 kΩ, 1%	RN55D	AB
R37	Resistor, Fixed, 499 kΩ, 1%	RN55D	AB
R38	Resistor, Fixed, 499 kΩ, 1%	RN55D	AB
R39	Resistor, Fixed, 499 kΩ, 1%	RN55D	AB
R40	Resistor, Fixed, 499 kΩ, 1%	RN55D	AB
R41	Resistor, Fixed, 499 kΩ, 1%	RN55D	AB
R42	Resistor, Fixed, 499 kΩ, 1%	RN55D	AB
R43	Resistor, Fixed, 10 kΩ, 1/4 W, 5%	72PMR10K	Beckman
R44	Resistor, Fixed, 75 Ω, 1/2 W, 5%	RC20G	AB
R45	Resistor, Fixed, 75 Ω, 1/2 W, 5%	RC20G	AB
R46	Resistor, Fixed, 11 kΩ, 1/2 W, 5%	RC20G	AB

Ref. No.	Description	Part No.	Mfr.

MODEL 3980-404 CRT DISPLAY BOARD PARTS LIST

Ref. No.	Description	Part No.	Mfr.
C1	Capacitor, Tantalum, 2.2 µfd, 15 V	CS13BE225K	Kemet
C2	Capacitor, Ceramic Disc, .001 µfd, 1000 V, 20%	DD-102G	Sprague
C3	Capacitor, Polystyrene, .01 µfd, 33 V, 1%	611.3S10000F	Mial
C4	Capacitor, Polycarbonate, .01 µfd, 250 V, 5%	B32541C-.01/5/250	Siemens
C5	Capacitor, Ceramic Disc, 0.1 µfd, 20 V, 20%	UK20-104	CRL
C6	Capacitor, Tantalum, 22 µfd, 15 V	CS13BD226K	Kemet
C7	Capacitor, Tantalum, 22 µfd, 15 V	CS13BD226K	Kemet
C8	Capacitor, Ceramic Disc, 0.1 µfd, 20 V, 20%	UK20-104	CRL
C9	Capacitor, Tantalum, 22 µfd, 15 V	CS13BD226K	Kemet
C10	Capacitor, Electrolytic, 680 µfd, 6.3 V	687HGR3DM5C	Sprague
C11	Capacitor, Ceramic Disc, .1 µfd, 20 V, 20%	UK20-104	CRL
C12	Capacitor, Tantalum, 22 µfd, 15 V	CS13BD226K	Kemet
C13	Not Used		
C14	Capacitor, Polycarbonate, .01 µfd, 250 V, 5%	B32541C-.01/5/250	Siemens
C15	Capacitor, Ceramic Disc, 0.1 µfd, 20 V, 20%	UK20-104	CRL
C16	Capacitor, Tantalum, 22 µfd, 15 V	CS13BD226K	Kemet
C17	Capacitor, Polycarbonate, .01 µfd, 250 V, 5%	B32541C-.01/5/250	Siemens
C18	Capacitor, Ceramic Disc, .02 µfd, 1 k V	5GA-S20	Sprague
C19	Not Used		
C20	Capacitor, Ceramic Disc, .02 µfd, 1 k V	5GA-S20	Sprague
C21	Not Used		
C22	Capacitor, Ceramic Disc, .02 µfd, 1 k V	5GA-S20	Sprague
C23	Not Used		
C24	Capacitor, Ceramic Disc, .02 µfd, 1 k V	5GA-S20	Sprague
C25	Not Used		
C26	Capacitor, Polycarbonate, .01 µfd, 250 V, 5%	B32541C-.01/5/250	Siemens
C27	Capacitor, Electralytic, 20 µfd, 250 V	39D206F250EL4	Sprague
C28	Capacitor, Ceramic Disc, .005 µfd, 3 k V	30GA-D50	Sprague
D1	Diode, Silicon	1N3064	TI
D2	Diode, Silicon	1N3064	TI
D3	Diode, Silicon	1N3064	TI
D4	Diode, Silicon	1N3064	TI
D5	Diode, Silicon	1N3064	TI
D6	Diode, Silicon	1N4002	Motorola
D7	Diode, Silicon	1N4002	Motorola
D8	Diode, Silicon	1N3064	TI
D9	Diode, Silicon	1N3064	TI
D10	Diode, Silicon	1N3064	TI
D11	Diode, Silicon	1N3064	TI
D12	Diode, Silicon	1N4937	Motorola
D13	Diode, Silicon	1N4937	Motorola
D14	Diode, Silicon	1N4937	Motorola
D15	Diode, Silicon	1N4937	Motorola
D16	Diode, Silicon, High Voltage	MR-250-3	Motorola
D17	Diode, Silicon	1N3064	TI
D18	Diode, Silicon	1N3064	TI
D19	Diode, Silicon	1N3064	TI
L1	Inductor, 40 µH	5240	J. W. Miller
L2	Inductor, 1.0 µH	WEE1000	Nytronics
L3	Inductor, 56 µH	WEE5600	Nytronics
Q1	Transistor, Silicon PNP	MM5005	Motorola
Q2	Transistor, Silicon NPN	MM3005	Motorola
Q3	Transistor, Silicon	2N5630	Motorola
Q4	Transistor, Silicon	2N5630	Motorola
Q5	Transistor, Silicon PNP	MM5005	Motorola
Q6	Transistor, Silicon NPN	MM3005	Motorola
Q7	Transistor, Silicon	2N4401	Motorola
Q8	Transistor, Silicon PNP	MM5005	Motorola
R1	Resistor, Fixed, 20 kΩ, 1/4 W, 5%	RCR07	AB
R2	Resistor, Fixed, 470 kΩ, 1/4 W, 5%	RCR07	AB
R3	Resistor, Fixed, 2.49 kΩ, 1%	RN55D	AB
R4	Resistor, Fixed, 4.99 kΩ, 1%	RN55D	AB
R5	Resistor, Fixed, 4.99 kΩ, 1%	RN55D	AB
R6	Resistor, Fixed, 200 Ω, 1/4 W, 5%	RCR07	AB
R7	Resistor, Fixed, 10 kΩ, 1/4 W, 5%	RCR07	AB
R8	Resistor, Fixed, 1.0 kΩ, 1/4 W, 5%	RCR07	AB
R9	Resistor, Fixed, 200 Ω, 1/4 W, 5%	RCR07	AB
R10	Resistor, Fixed, 2.2 kΩ, 1/4 W, 5%	RCR07	AB
R11	Resistor, Fixed, 10 Ω, 1/2 W, 5%	RC20G	AB
R12	Resistor, Fixed, 470 Ω, 1/4 W, 5%	RCR07	AB
R13	Resistor, Fixed, .27 Ω, 2 W, 10%	BWH	TRW
R14	Resistor, Fixed, 100 Ω, 1/4 W, 5%	RCR07	AB
R15	Resistor, Fixed, 10 Ω, 1/2 W, 5%	RC20G	AB
R16	Resistor, Fixed, 1.0 kΩ, 1/4 W, 5%	RCR07	AB
R17	Resistor, Fixed, 200 Ω, 1/4 W, 5%	RCR07	AB
R18	Resistor, Fixed, 2.2 kΩ, 1/4 W, 5%	RCR07	AB
R19	Resistor, Fixed, 10 kΩ, 1/4 W, 5%	RCR07	AB
R20	Resistor, Fixed, 200 Ω, 1/4 W, 5%	RCR07	AB
R21	Resistor, Fixed, 365 kΩ, 1%	RN55D	AB
R22	Resistor, Fixed, 2.0 kΩ, 1/4 W, 5%	RCR07	AB
R23	Resistor, Fixed, 4.02 kΩ, 1%	RN55D	AB
R24	Resistor, Fixed, 10 kΩ, 1/4 W, 5%	RCR07	AB
R25	Resistor, Fixed, 2.2 kΩ, 1/4 W, 5%	RCR07	AB
R26	Resistor, Fixed, 200 Ω, 1/4 W, 5%	RCR07	AB
R27	Resistor, Fixed, 1.0 kΩ, 1/4 W, 5%	RCR07	AB
T1	Transformer	TM3335	Transf. Inc

Ref. No.	Description	Part No.	Mfr.

MODEL 3980-504 CRT DISPLAY BOARD PARTS LIST

Ref. No.	Description	Part No.	Mfr.
C1	Capacitor, Ceramic Disc, .01 mfd, 50 V, 20%	UK50-103	CRL
C2	Capacitor, Ceramic Disc, .01 mfd, 50 V, 20%	UK50-103	CRL
C3	Capacitor, Ceramic Disc, .01 mfd, 50 V, 20%	UK50-103	CRL
C4	Capacitor, Electrolytic, 220 mfd, 25 V	B41283/220/25	Siemens
C5	Capacitor, Electrolytic, 220 mfd, 25 V	B41283/220/25	Siemens
C6	Capacitor, Ceramic Disc, .01 mfd, 50 V, 20%	UK50-103	CRL
R1	Resistor, Fixed, 100 kΩ, 1%	RN55D	AB
R2	Resistor, Fixed, 200 kΩ, 1%	RN55D	AB
R3	Resistor, Fixed, 75.0 kΩ, 1%	RN55D	AB
R4	Resistor, Fixed, 100 kΩ, 1%	RN55D	AB
R5	Resistor, Fixed, 18.2 kΩ, 1%	RN55D	AB
R6	Resistor, Fixed, 90.0 kΩ, 1%	RN55D	AB
R7	Resistor, Fixed, 100 kΩ, 1%	RN55D	AB
R8	Resistor, Fixed, 24.9 kΩ, 1%	RN55D	AB
R9	Resistor, Fixed, 36.5 kΩ, 1%	RN55D	AB
R10	Resistor, Fixed, 100 kΩ, 1%	RN55D	AB
R11	Resistor, Fixed, 332 kΩ, 1%	RN55D	AB

Ref. No.	Description	Part No.	Mfr.

MP MASTER
MA25788